Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the matter of	)	
	)	
Service Rules for the 698-746, 747-762, and 777-792 MHZ Bands	)	WT Docket No. 06-150
	)	
Implementing a Nationwide, Broadband, Interoperable Public Safety Network in the 700 MHZ Band	)	PS Docket No. 06-229
	)	
Implementation of the Commercial Spectrum Enhancement Act and Modernization of the Commission's Competitive Bidding Rules and Procedures	)	WT Docket No. 05-211
	)	
Development of Operational, Technical, and Spectrum Requirements for Meeting Federal, State and Local Public Safety Communications Requirements Through 2010	)	WT Docket No. 96-86

EX PARTE COMMENTS OF THE *AD HOC* PUBLIC INTEREST SPECTRUM COALITION

To: The Commission

Media Access Project, on behalf of Consumers Union, Consumer Federation of America, Free Press, New America Foundation and Public Knowledge (collectively referred to here as the "Public Interest Spectrum Coalition" or "PISC"), files these *ex parte* comments addressing the proposal submitted by Frontline, the proposed Band Optimization Plan, and auction and service rules needed to ensure that this auction of unique and highly valuable spectrum will maximize the likelihood of competitive entry in broadband wireless that protects public safety, increases opportunities for minority and women owned businesses, and promotes broadband access by ***all*** Americans.

SUMMARY

Only by adopting significant changes to the auction rules and service rules can the Commission hope to auction the uniquely important 700MHz spectrum in a manner that both maximizes the public

interest and returns maximum value for the use of the public asset. The first of these would be to embrace the Frontline proposal to create a new, open access wireless wholesaler. To facilitate that result, the Commission should immediately solicit public comment on that plan. Other necessary changes are the adoption of anonymous bidding and package bidding, and conclusion of the *Further Notice of Proposed Rulemaking* on DE eligibility. The Commission should also either prohibit wireline and large wireless incumbents from bidding, or require them to bid through structurally separate affiliates operating under an "open access" condition similar to the Commission's *Computer III* regime.

In addition, the Commission should consider new ways to address the problem of warehousing. PISC recommends permitting unlicensed devices approved for operation in the broadcast "white spaces" to operate where licensees have missed their build out requirements by treating these unbuilt systems as "vacant channels" until the licensee complies. Alternatively, the Commission should consider other forms of self-executing remedies that create an incentive to avoid warehousing. Further, although the Commission should adopt the so-called "band optimization plan," it should reject the suggestion that it attempt a "reverse auction," as a means of allocating use of the guard bands after the fact. Finally, although the Commission should ensure a sufficient number of small licenses for the benefit of smaller rural carriers, it must balance this against the greater need of allowing new entrants to construct national footprints.

ARGUMENT

The AWS auction this past summer demonstrated that continuing to hold open, ascending auctions to distribute virtually unregulated licenses merely serves to enhance the stranglehold of incumbents and the designated entities with whom they have material relationships. An exhaustive analysis conducted by Dr. Gregory Rose shows that wireless and cable incumbents actively sought

to block DBS providers and other potentially disruptive competitors from establishing a national footprint ("Rose AWS Analysis").[1] Analysis of the AWS auction also suggests that incumbents financed the participation of a sufficient number of designated entities to avoid anonymous bidding.

Thus, while loudly touted as a great success, the AWS auction failed to achieve any of the public interest goals mandated by Congress. Indeed, treating the AWS auction as a standalone market, and excluding the nonsalient entrants who entered merely to inflate the initial eligibility ratio artificially and thus avoid anonymous bidding, AWS license distribution has the highest HHI of any major FCC auction. Not only did the AWS auction fail to introduce new, disruptive competitors and fail to create new opportunities for women and minority owned businesses to deliver wireless services, but the AWS auction also failed to maximize revenue. As Dr. Rose demonstrates, the AWS licenses were sold at bargain prices using the standard MHz/pop analysis.

Further, as demonstrated by a recent filing by former FCC Chief Economist Simon Wilkie on behalf of M2Z ("Wilkie Auction Analysis") (Attachment A), incumbents have used the auction process to block entry into related broadband markets. Incumbents have consistently warehoused valuable spectrum to keep it out of the hands of competitors and to avoid disrupting their existing business models. The increased concentration in the wireless market, coupled with vertical integration of wireless and wireline incumbents, has made blocking and warehousing both easier and more attractive.

I. THE COMMISSION SHOULD ADOPT THE FRONTLINE PROPOSAL, SUBJECT TO CERTAIN SAFEGUARDS

The Commission should adopt the proposal to create a new, national "E Block" license as proposed by Frontline. To facilitate this outcome, the Commission should immediately solicit and

[1]The Rose AWS analysis will be separately filed in this docket on or before April 10, 2007.

expedite public comment on the Frontline proposal.

The Frontline proposal will create a valuable national wholesale provider of usable spectrum for competing wireless providers. This model will provide much needed spectrum to minority and women owned businesses and rural providers, WISPs, and others that have complained that they cannot find sufficient usable spectrum in the secondary markets. In addition, the proposal conveys the key benefits of the Cyren Call proposal to the public safety community without requiring an allocation of an additional 30 MHZ of spectrum.

A. Frontline Confers Valuable Benefits To The Public As Well As To The Public Safety Community.

The Frontline proposal enumerates the numerous benefits to the public safety community and general spectrum efficiency from its proposal. But the proposal also provides significant benefit to the general public above and beyond the contribution to public safety.

The Frontline proposal appears to be the most likely means of ensuring an open, neutral wireless broadband network available on a national basis in the near future. Given the Commission's determination to rely exclusively on "the market" to resolve the critical public policy issues of broadband competition and network neutrality, the Commission should take this necessary action to ensure that a neutral wireless provider exists. Otherwise, vertically integrated incumbents will have no incentive to open their networks and will continue to offer only packages that seek to leverage their market power.

The Commission has consistently refused to require that wireless providers offer wholesale access to scarce spectrum or comply with the same network attachment rules as wireline networks. Instead, the Commission has preferred to rely on voluntary mechanisms such as its secondary market

rules. Initially, the Commission justified this laissez faire policy first on the grounds that wireless services were "nascent" industries. More recently, the Commission has relied on the theory that competition and the need to increase revenues would drive wireless providers to explore wholesale markets while courting customers by providing open networks.

Unfortunately, the Commission's narrow view of market structure and acceptance of a highly simplified view of market incentives has failed to produce a single, national open wireless network. Nor has it made spectrum available to new entrants. To the contrary, horizontal consolidation in the wireless market and vertical consolidation of wireline telecommunications providers and wireless providers has created a world in which wireless networks have greater incentive to create "walled gardens" for subscribers, exact rents from equipment manufacturers, and warehouse spectrum to maintain scarcity and prevent the emergence of competition.

A recent New America Foundation Working Paper by Columbia Professor Tim Wu meticulously documents how the wireless industry has responded to the Commission's failure to impose sufficient consumer safeguards. *See* Tim Wu, "Wireless Net Neutrality: Cellular *Cartefone* and Consumer Choice in Mobile Broadband," New America Foundation (2007). As Professor Wu documents, the wireless carrier industry has evolved into a cartel (Wu uses the term "spectrum oligopoly") with its largest members either vertically integrated with the largest incumbent telephone providers or in strategic relationships with the largest cable providers. This in turn drives the "spectrum oligopoly" to seek to control the nature of innovation on their network so as to maximize the rents extracted from equipment manufacturers or those seeking to offer new services, as well as protect the core voice and/or data businesses of their ILEC or cable partners.

In such an environment, the Commission must reevaluate its expectation that competitive

pressures will prod wireless networks into business models that maximize consumer welfare. Absent regulatory changes that would require wireless networks to operate in a neutral manner and permit subscribers to attach devices to their networks, it seems remarkably unrealistic to assume that any of the national incumbents will change their behavior.

For similar reasons, the expectation that carriers will release significant spectrum for competing services voluntarily is equally unrealistic. WISPs and others have repeatedly complained that carriers would prefer to warehouse spectrum and forgo wholesale revenue rather than create retail competitors. Rural communities and minority communities consistently complain that they are underserved, to the point that such communities have increasingly taken action to provision themselves *via* available unlicensed spectrum, yet incumbents keep valuable spectrum warehoused rather than make it available through the secondary markets. It seems far more probable that they do so because they wish to maintain scarcity and discourage the entry of competitors rather than because wholesale wireless does not offer a viable business model. Again, therefore, absent Commission action, no wholesale wireless providers will emerge.

Ideally, the Commission would impose such rules on the wireless industry generally as the regulatory regime that best serves the public interest. At the least, however, with a proposal to introduce such an open access wireless provider into the market ***voluntarily***, the Commission should seize it with both hands. Further, because of the unique nature of the 700 MHZ band, a national licensee operating on wholesale basis can provide significant improvement by helping to disrupt the existing *status quo*.

PISC stresses that a single national wholesale licensee does not, in and of itself, eliminate the need for a generally applicable rule on network attachments and network neutrality. But the

introduction of such a licensee will create measurable improvements by making spectrum available to wireless entrepreneurs. In particular, communities that do not provide sufficient potential revenue to entice the incumbents to deploy, yet remain starved for spectrum that the incumbents have warehoused, will benefit.

B. The Commission Must Impose Safeguards To Prevent Incumbents From Capturing The E Block Spectrum.

As explained in the Wilkie Auction Analysis, incumbents can and have engaged in several successful strategies to warehouse spectrum to keep it from potential competitors. The greatest danger to the E Block therefore is not, as some suggest, that it will attract few bidders. To the contrary, it is far more likely – if the Commission adopts the Frontline proposal – that the incumbents will attempt to win the E Block for themselves. As the E Block licensee, an incumbent can satisfy the public safety build out requirements yet stymie the effort to create a wholesale spectrum market. Alternatively, the incumbents may seek to eliminate the threat of competition by leasing significant spectrum from the E Block licensee for the sole purpose of depriving would-be rivals of capacity.

Should Frontline succeed in becoming the E Block licensee, it would undertake to operate exclusively as a wholesaler, making its network available to all retail service providers, selling "minutes" (or, perhaps more accurately, megabits) instead of leasing its spectrum.[2] However, there is nothing in the service rules proposed by Frontline in its March 27 ex parte letter that would impose a wholesale-only license condition on Frontline or on any other holder of the E Block license, or that would otherwise restrict the E Block licensee from leasing substantial portions of its capacity to

[2]See Frontline Comments filed February 26, 2007 at 9 n. 10. See also, Frontline Reply Comments filed March 12, at 8, n. 21: "The network operator would provide and enable authentication, authorization, and accounting functionality...."

incumbents to keep that capacity inaccessible to potential rival operators. Accordingly, PISC recommends that the Commission adopt one of several alternative mechanisms to guard against warehousing of 700 MHz spectrum capacity.

In the past, the Commission has used three mechanisms to promote competition in the face of entrenched incumbents. First, the Commission has at times resorted to a complete cross-ownership or bidding ban. For example, the Commission prohibited incumbent cable operators from acquiring MDS and MMDS (now BRS) licenses in the hopes of promoting "wireless cable" as a competitive alternative. *See Report and Order in Gen. Dockets Nos. 90-54 and 80-113*, 5 FCCRcd 6410 (1990). Second, the Commission has used spectrum caps to ensure that a suitable number of competitors will emerge in the market place. *See In re Amendments to Parts 20 and 24 of the Commission's Rules – Broadband PCS and Competitive Bidding and the Commercial Mobile Radio Service Cap*, 11 FCCRcd 7824 (1996). *See also In re Revision of Rules and Policies for the Direct Broadcast Satellite Service*, 11 FCCRcd 9712 (1995) (adopting one-time rule prohibiting incumbent licensees from bidding on new satellite slots). Third, the Commission has required operators with market power to operate using separate affiliates, so that the Commission can monitor and prevent discrimination by incumbents in favor of their own affiliates. Of great relevance here, the Commission's use of separate affiliates under the *Computer II* & *Computer III* regimes permitted the emergence of a vibrant and competitive ISP market that created the internet revolution of the 1990s.

The Commission should give careful consideration to adopting one of these three mechanisms to prevent capture of the E Block license either through the auction or afterward by leasing the full capacity of the E Block licensee. The Wilkie Auction Analysis, discussed in Part I.A above, provides a lengthy discussion of the theory of warehousing with numerous examples of ongoing spectrum

warehousing by incumbents. It makes no irrational leap to assume that the incumbents would prefer to capture the E Block license and stifle the wholesale market rather than see a vibrant wholesale market for competitors emerge, even at the additional cost of building out a national public safety system.

A report published last year by the Center for American Progress provides additional proof that incumbents have consistently manipulated the auction process to exclude potentially disruptive new entrants. Gregory Rose and Mark Lloyd, "The Failure of FCC Spectrum Auctions," (Center for American Progress, 2006) ("CAP Report") (Attachment B). A wealth of academic literature on auctions supports a similar conclusion. *See, e.g.*, Sandro Brusco and Guiseppe Lopomo, "Collusion *via* Signaling in Simultaneous Ascending Bid Auctions With Heterogenous Objects, With and Without Complimentarities," 69 Review of Economic Studies 407 (2002); Perry M. And P. Renny, "On the Failure of the Linkage Principle In Multi-Unit Auctions," 67 Econometrica 895-200 (1999) (cited in Wilkie Auction Analysis at 41).

Given this extensive academic literature, the numerous examples of warehousing compiled by Dr. Wilkie, and the 10 year review of FCC auctions in the Center for American Progress Report, the record more than adequately supports a ban on participation in the 700 MHZ auction by ILECs, incumbent cable operators, and large wireless carriers. Absent a general ban, such dominant providers of broadband and wireless services should, at the least, be excluded from bidding on the single E Block license that has the capacity to create new, disruptive providers of wireless services.

If the Commission remains determined to allow broadband and wireless incumbents to bid for the E Block license, the Commission should at least require them to do so *via* structurally separate affiliates. This way, the Commission can easily determine whether the incumbents are favoring their

own services or seeking to discriminate against unaffiliated providers. The separate affiliate requirement proved extremely effective in promoting a vibrant and competitive ISP industry until the Commission began to repeal the policy in the interest of promoting deployment of new fiber networks. While not as effective as an outright ban on participation, a separate affiliate requirement would at least provide some minimal protection to new entrants hoping to lease E Block spectrum.

For the reasons discussed above, the Commission must also take steps to ensure that the incumbents do not block new entrants by leasing the available capacity of an independent E Block provider. PISC suggest the following mechanisms:

Ideally, the Commission would prohibit wireless carriers from leasing E Block capacity within the coverage areas of their licenses, and would prohibit incumbent wireline providers from leasing E Block capacity within their franchise areas. Given the availability to these incumbents of their own wireless spectrum and fiber, it seems far more likely that any capacity leased stems from the desire to exclude competitors from a critical resource rather than commercial necessity.

If the Commission balks at such a complete prohibition, the Commission should limit the capacity that an E Block licensee can lease to such incumbents. PISC suggests that the Commission require the E Block licensee to keep at least 75% of its capacity available for non-incumbents. While incumbents could lease genuinely unused capacity, the Commission should require that non-incumbents can displace incumbent use until the 75% capacity limit is reached. Finally, in the event that public safety entities need access to the E Block spectrum, incumbent operators rather than non-incumbents should be subject to displacement first.

Finally, at the very least, the Commission should prohibit lease terms that favor incumbent traffic over non-incumbent traffic. The Commission should prohibit “option contracts” or “rights of

first refusal" that would allow incumbents to tie up capacity without using the spectrum themselves. As a general matter, the Commission should prohibit any contract that would prevent the E Block licensee from leasing available capacity. While such an arrangement might prove highly profitable to the E Block licensee, it would defeat the purpose of the E Block license of making much needed spectrum available to new entrants.

C. Nothing In The Statute Or Commission Precedent Prevents Adoption of the Frontline Proposal or the Modifications Proposed By PISC.

Nothing in the Commission's recent actions on wireless or the statutory requirement that certain frequencies be auctioned for commercial use or allocated to public safety prohibits the Commission from adopting the Frontline proposal. To the contrary, the proposal will promote the statutory goals of Sections 309(j)(3)(A)-(B) and 309(j)(4)(C)-(D).

In requiring the Commission to auction 60 MHZ of returned analog broadcast spectrum, Congress did not in any way limit the Commission's general authority to create service rules. Accordingly, the Commission has the same authority to set service rules for the licenses distributed in this auction as in any other. Similarly, Congress left to the discretion of the Commission the manner in which it was to make 24 MHZ available for public safety. It placed no limits on the Commission's discretion to fashion novel approaches – such as a public-private partnership that effectively doubles the spectrum available to public safety – that would best suit the unique characteristics of this band.

Further, as discussed above, the Frontline proposal will make spectrum more widely available, particularly to underserved rural communities and minority communities. It will encourage an even distribution of spectrum availability among the states by creating a national license, and facilitate new access to spectrum and spectrum services by women-owned and minority-owned businesses. *See*

Sections 309(j)(3)(A)-(B), 309(j)(4)(C)-(D). By contrast, as described in the Center for American Progress Report, the Commission's standard auction mechanisms have proven woefully inadequate for achieving these purposes.

Nor does the Frontline proposal contradict the Commission's recent *Declaratory Ruling* classifying wireless broadband as an information service. *In re Appropriate Regulatory Treatment for Broadband Access to the Internet Over Wireless Networks*, WT Docket No. 07-53 (rel. March 23, 2007) ("*Wireless Broadband Declaratory Ruling*"). To the contrary, the *Wireless Broadband Declaratory Ruling* explicitly stated that the reclassification did nothing to alter the Commission's Title III authority or in any way altered specific service rules the Commission adopts. *Id.* at ¶35. Adopting a specific service rule for the E Block that clearly serves the public interest presents no contradiction or departure from this policy.

Finally, as Chairman Martin and Commissioner Tate observed in the context of the AT&T/BellSouth merger, a party may voluntarily assume additional public interest obligations to secure a Commission benefit even where such action is not required by rule. *In re AT&T Inc., and Bellsouth Corporation Application for Transfer of Control*, WC Docket No. 06-74 (rel. March 26, 2007) (Joint Statement of Chairman Kevin J. Martin and Commissioner Deborah Tate). Nothing compels any party to bid for the proposed E Block license. Those wishing to maintain closed wireless networks using other spectrum are free to continue to do so. Certainly they cannot object when the Commission chooses to create an incentive to encourage the emergence of a new, neutral wireless provider and others wish to avail themselves of the option.

II. THE COMMISSION SHOULD ADOPT ANONYMOUS BIDDING, PACKAGE BIDDING, AND OTHER MECHANISMS TO ENCOURAGE COMPETITIVE ENTRY.

Prior to the AWS auction, the Wireless Bureau proposed to adopt "anonymous" bidding to limit the ability of incumbents to block new entrants and prevent collusion by signaling. Despite support for the proposal from consumer advocates, the Federal Trade Commission, and the Department of Justice, the Commission chose to adopt an industry compromise proposal which reverted to the standard open format if a sufficient number of bidders entered the auction. The number of bidders almost exactly equaled the minimum number necessary to produce the required "competition ratio," and Auction 66 operated under the Commission's standard simultaneous multiple round (SMR) rules.

The Commission's initial intuition that only anonymous bidding could prevent signaling proved correct. The Rose AWS Analysis demonstrates that incumbents used signaling behavior and otherwise acted to prevent potentially disruptive new entrants from creating a national footprint and, when potentially disruptive new entrants were eliminated, acted in concert to divide licenses among themselves at the lowest possible cost. This result is consistent with the evaluation of FCC auctions generally published by the Center for American Progress (Attachment B) and the recently submitted Wilkie Auction Analysis. It is also consistent with the analysis in support of combinatorial and "package" bidding proposal submitted by Dr. Gregory Rosston on behalf of Access Spectrum and Pegasus Spectrum. *See* Letter of Ruth Milkman and Kathleen Wallman, WT Docket No. 06-150, filed February 5, 2007 ("Rosston Proposal").

A. Anonymous Bidding Is Critical To Promoting Competitive Entry and Eliminating Collusion By Incumbents.

Accordingly, PISC strongly urges the Commission to adopt the anonymous bidding rules originally proposed by the Wireless Bureau for the AWS auction. *See* Public Notice, "Auction of

Advanced Wireless Services Licenses Scheduled for June 29, 2006," 21 FCCRcd 794 (2006). Under the proposed rules, the Commission would conceal from bidders the identity of the bidders and the non-winning bids. Bidders would see only the highest bid for a license, not associated with any other information.[3] The Commission should abandon the "eligibility ratio" compromise it ultimately adopted, *Advanced Wireless Services Auction*, 21 FCCRcd 4562 (2006), and use anonymous bidding for all licenses.

In the AWS auction, the Department of Justice Antitrust Division, the Federal Trade Commission, and a coalition of consumer groups, civil rights organizations, and others argued that the record of the last ten years of FCC auctions, the success of anonymous auctions in Europe, and the weight of academic literature favored adopting anonymous bidding to prevent collusion by incumbents. In a united effort, all wireless incumbents argued against anonymous bidding for reasons varying from the efficiency of open auctions to the need for smaller bidders to avoid "bidding wars" with larger incumbents.

In the end, the Commission adopted the "eligibility ratio compromise" proposed by T-Mobile. Under this rule, the Commission would conduct the auction under its standard open auction rules if the total number of bidding units of eligibility purchased by bidders relative to the total number of bidding units for the licenses in the auction, subject to a cap on any single bidder's eligibility of 50% of the total bidding units, equaled 3 or more. Ultimately, 168 bidders qualified, with sufficient bidding credits to create a ratio 3.04. *Public Notice, Auction of Advanced Wireless Service Licenses*, 21 FCCRcd 8585 (2006).

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[3]The Commission should capture the standard information on bidding behavior, however, to monitor the conduct of the auction. The Commission should also publish the information after the completion of the auction to facilitate independent analysis.

The presence of a sufficient number of bidders to just meet the eligibility ratio should raise eyebrows. Analysis of the bidding behavior of a number of designated entities with ties to the incumbents raise further concerns that several such DEs had no intent to seriously participate. While not proof in a legal sense, the combination of an eligibility ratio of 3.04 with the lackluster bidding by DEs with material relationships with incumbents that benefitted from using open bidding rather than anonymous bidding strongly suggests that incumbents once again "gamed the system" to achieve a competitive advantage.

The results of the auction speak for themselves. Once again, the major incumbents – this time joined by broadband cable incumbent Spectrum Co. – worked to exclude the DBS bidders and other potentially disruptive competitors that might offer broadband or wireless service on terms different than those of incumbents.

Those touting the auction as a success generally point to the emergence of regional competitors as potential national competitiors, and the entry of Spectrum Co. as a "new entrant" into the wireless market. Neither of these represents the emergence of a genuine new competitor. With regard to the regional carriers, their elevation to national prominence is unlikely to produce significant benefits for consumers, since they operate under the same closed network model and offer comparable products at comparable prices. Further, there is evidence that the larger incumbents will simply purchase any carrier with sufficient capacity to create real competition. The rumored purchase of Alltel by Verizon Wireless is a classic example of how incumbents use the auction process to exclude potentially disruptive new entrants while dividing licenses among themselves – resolving any further threat of competition through the simple expediency of buying out potential rivals later.

Nor does the strong showing of Spectrum Co. change the analysis that an open auction pro-

vided the opportunity to keep rivals away from a critical resource needed to compete in the communications marketplace. To the contrary, the ability of the largest video and residential broadband incumbents to exclude their chief video rivals from offering terrestrial wireless voice and data services proves this very point. As documented by Dr. Wilkie, Spectrum Co. has repeatedly denied plans to use the AWS spectrum in a manner that might genuinely threaten the "spectrum oligopoly" described by Wu.

Only a myopic focus on the commercial mobile radio service as the relevant "market" justifies viewing Spectrum Co. as a "new entrant" rather than exactly the sort of incumbent the Commission should exclude to promote competition. Yet this approach flatly contradicts the Commission's oft-repeated view that it depends on the emergence of new, competitive broadband platforms – particularly wireless – as a reason to deregulate all broadband platforms. If the Commission genuinely wishes to see broadband competition emerge on multiple platforms, it must broaden its horizons and consider the largest residential broadband providers, incumbent cable companies and incumbent telephone companies as "incumbents" that threaten the growth of competitive broadband rather than as potential new entrants in mobile wireless telephony.

Because of its unique properties, the 700 MHZ band offers the single greatest hope for the foreseeable future of licensed competitive terrestrial broadband. The arguments in favor of anonymous bidding by FCC staff in the initial *AWS Public Notice* – supported by public interest organizations, the Department of Justice, and the Federal Trade Commission – proved themselves in the AWS action. To the extent the "eligibility ratio" proposed by T-Mobile has merit, the ratio selected by the Commission proved too low despite the insistence of T-Mobile that an even lower ratio would have sufficed. In any event, the incumbents have demonstrated they can game the system to meet any proposed ratio, and their apparent willingness to do so should speak volumes. Rather than squander

the one chance to distribute this unique "rocket fuel" for broadband competition, the Commission should restore the anonymous bidding rules it initially proposed for the AWS auction in January 2006.

B. Package Bidding, Done Properly, Can Promote Competitive Entry.

PISC supports the Rosston Proposal to allow package and combinatorial bidding, with two proposed additional safeguards. First, the Commission should not make public the authors of proposed packages. A skilled analyst could, with such knowledge, determine the bidding strategy of the package author and develop a suitable blocking strategy. Second, the Commission must have some mechanism to screen out packages designed to block creation of a national footprint.

As discussed above, the weight of evidence from previous Commission auctions demonstrates that if the Commission intends to promote competitive entry, it must take serious steps to prevent incumbents from blocking new entrants. Creating packages for the sole purpose of blocking new entrants takes relatively little effort or resources. A relatively small number of small packages consisting of a few key licenses can prevent new entrants from acquiring a national footprint. In such a situation, incumbents intent on blocking can concentrate bids on their smaller packages, while potential new entrants must bid on a much larger number of licenses. When the ability to submit "blocking packages" is combined with open bidding, or combined with knowledge of the nature of the package and how it will integrate into a potential competitor's system, blocking becomes a trivial exercise requiring only the willingness to spend money to protect market power.

C. Other Necessary Safeguards to Promote Competitive Entry and Prevent Abuses By Incumbents.

The 700 MHz auction represents the best opportunity to introduce a new broadband provider, as well as provider of 4G mobile services. The history of spectrum auctions and subsequent delivery

of competitive services demonstrates that, absent Commission action, incumbents will win the majority of licenses and warehouse the spectrum. History also shows, however, that the Commission is reluctant to reclaim licenses for failure to meet build out requirements. In addition, efforts to reclaim licenses face legal challenges and lengthy delays before the Commission can reassign licenses to productive users. The pending *Further Notice of Proposed Rulemaking* on designated entity (DE) credits addresses some of these issues in the context of whether to permit DEs to maintain material relationships with large incumbent carriers or other entities. PISC therefore proposes that the Commission adopt the following rules to promote competitive entry to ensure that all Americans enjoy the benefit of wireless services in accordance with Section 309(j) of the Act.

1. Limits On Incumbent Participation In the Auction.

As discussed above in Part I.B, the Commission should adopt procedures it has employed in the past to encourage the entry of new competitors and prevent incumbents (whether traditional wireless services incumbents or wireline broadband incumbents) from capturing the available licenses. Ideally, the Commission should impose a full ban on bidding and ownership of 700 MHZ licenses by incumbent wireline or incumbent wireless providers. Given the documented willingness of incumbents to warehouse spectrum and buy out potential rivals, a full ban on bidding or post-auction ownership of 700 MHZ licenses by wireless or wireline incumbents provides the greatest likelihood that a new wireless broadband competitor will emerge.

Alternatively, if the Commission remains unwilling to include wireline broadband providers within the scope of the relevant market, the Commission should impose a spectrum cap prohibition. Since elimination of the general PCS spectrum cap, consolidation in the wireless industry has reduced the number of national and regional competitors to the point where a handful of national and large

regional providers control the vast majority of CMRS customers. Potential wireless competitors such as Clearwire have yet to emerge as significant players. Indeed, as Clearwire argued during the pendency of the AT&T/Bellsouth merger, warehousing of valuable spectrum by the dominant CMRS licensees outside the PCS spectrum significantly impedes the development of wireless competition in other bands. *In re Bellsouth Corporation and AT&T, Inc., Application for Transfer of Control, Petition to Deny of Clearwire, Inc.*, WT Docket No. 06-74 (filed June 5, 2006).

The unique nature of the 700 MHZ licenses and its potential for fostering wireless competition and new services justifies a service-specific spectrum cap. The Commission should prohibit any entity with more than 45 MHZ available in PCS, AWS, 2.3 GHz or 2.5 Ghz spectrum from acquiring a 700 MHZ license using rules modeled on the previous 45 MHZ CMRS cap. *See Broadband Competitive Bidding and PCS Cap*, 11 FCCRcd at 7869-7876 (describing and justifying cap). Given the success of Spectrum Co. in the AWS auction, and the integration of wireless operations into Verizon and AT&T, this prohibition will protect 700 MHZ licenses from the largest wireline broadband incumbents.

Finally, if the Commission balks at a permanent exclusion, the Commission should at least take action to prevent incumbents from blocking potential new entrants. Commission precedent exists for a one-time rule designed to enhance the likelihood that new entrants will succeed. *Revision of Rules and Policies for the Direct Broadcast Service*, 11 FCCRcd at 9720-9725 (one-time rule requiring a winner of full-CONUS DBS slot to divest its interest in all other full-CONUS licenses). As the Commission acknowledged then, the requirement that the Commission review any post-auction transactions will at least provide an opportunity for the Commission to determine if future purchase by an incumbent constitutes a danger to competition and diversity. *Id.* at 9724.

2. Rules to Address Spectrum Warehousing.

To address build out requirements, the Commission should shift to models that are self-executing rather than the all too often idle threat of revoking the license. PISC suggests that the Commission take advantage of the pending rulemaking set to authorize devices in the broadcast "white spaces," ET Docket No 04-186 ("White Spaces Proceeding").[4] The Commission may designate licenses that have failed to meet build out or service requirements as "vacant channels" accessible by such devices until the licensee completes build out and commences service. This will ensure that spectrum is used productively rather than warehoused, and provides suitable incentive for licensees to meet build out requirements after missing a deadline and securing a waiver.

Because the devices the Commission will approve in the white spaces proceeding will be designed to recognize introduction of a new licensee in the event the Commission authorizes a new television station in a vacant channel, there is no danger that use of the band will persist once the licensee meets its build out requirements. The devices operating in the license area will dynamically sense when the licensee begins operation of licensed services (either through sensing or some other means, such as beacons), eliminating any risk of interference. Nor can licensees complain that allowing unlicensed use in the band as a consequence of the Licensee's own failure to meet build out and service requirements somehow diminishes the value of the license or its expectation of exclusive use. Even were such quasi-ownership claims cognizable under the Communications act, a licensee can hardly argue that it has a right to warehouse spectrum in violation of the Commission's rules.

Alternatively, the Commission can simultaneously auction a "contingent license" with the 700

[4]This assumes the Commission chooses to permit unlicensed devices to operate in the white spaces, rather than licensing operation in the white spaces. Licensing operation in the white spaces would merely raise identical issues to those raised here.

MHz licenses. In the event that the 700 MHz licensee fails to meet its build out or service requirements, the license will automatically revert to the "contingent" licensee.[5] The threat that a license will transfer automatically if not used will provide powerful incentive for the winners of the 700 MHz auction to meet their obligations.

In both these cases, the winning bidder enters the auction knowing that a failure to build out and provide service cannot block competing use of the spectrum. Because of the self-executing nature of these remedies, licensees cannot hope to game the Commission's processes and avoid the consequences of their failure to build. This will diminish the incentive (and therefore the likelihood) or warehousing.

The Commission clearly needs to create such incentive. Despite stern language on the part of the Commission that it does not generally grant waivers of construction and service deadlines, it has repeatedly done so. Licensees know this, and rely upon it. Worse, where an entire industry decides to stonewall, the Commission is ***more*** likely to extend deadlines and grant waivers rather than face the political consequences of cancelling licenses for an entire class of incumbents. For example, the Commission recently extended the 2.3 GHz licenses of the 132 licensees, despite the failure of these licensees to build their systems over the course of ten years. *See Consolidated Request of the WCS Coalition for Limited Waiver of the Construction Deadline for 132 WCS Licenses*, 21 FCCRcd 14134 (2006). It is no coincidence that many holders of these licenses – Comcast, Verizon, Sprint Nextel, and (until divestiture) AT&T – are the same incumbents at issue here, with the same incentive to warehouse spectrum.

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[5]Commission contingent approval after the auction constitutes the necessary finding that the transfer will serve the public interest under Section 310(d). Alternatively, the Commission can employ an expedited transfer process to the "contingent licensee," if necessary.

The auction statute requires the Commission to develop effective rules against warehousing and speculation in Spectrum. 47 U.S.C. §309(j)(4)(B). The Commission has in the past relied upon the economic theory that winners at auction have an incentive to build out systems to recoup their auction revenues, and on the threat that it may revoke a license for a failure to comply with build out and service rules. Reality has proven the Commission's theory wrong and its threat hollow. An incumbent may prefer to warehouse spectrum where doing so provides a greater reward than cannibalizing its existing business model or allowing the spectrum to fall into the hands of rivals. If the Commission intends to comply with the intent of Congress and prevent spectrum warehousing, it must adopt new, self-executing mechanisms such as those suggested above.

3. Addressing The Use of Designated Entities To Block New Entrants.

Finally, to address concerns that incumbents use their relationships with DEs to block new entrants and win licenses at a substantial discount, the Commission must resolve the pending *FNPRM* and eliminate the ability of DEs to maintain material relationships with large wireline or wireless incumbents. The Commission has compiled a thorough record in this matter to justify prohibiting incumbents (either wireless or wireline) from maintaining material relationships with designated entities. The apparent use of designated entities by incumbents to artificially inflate the eligibility ratio for the AWS auction provides additional evidence for eliminating the ability of incumbents to form material relationships with DEs. Whatever public interest benefits may obtain from allowing such relationships, the demonstrated ability of incumbents to exploit these relationships for anticompetitive purposes outweighs them.

4. Restoring the Women and Minority DE Credit.

Additionally, the Commission should restore the DE credit for women and minority businesses

eliminated after the *Aderand* decision, as requested by National Hispanic Media Coalition, *et al.*, in the initial rulemaking. *See Comments of NHMC, et al.*, WT Docket No. 05-211 (filed February 24, 2006). As others have documented, auctions continue to disserve minority communities by excluding minority-owned businesses from owning needed licenses; wireless services in minority communities lag behind accordingly. *See* Leonard M. Baynes and C. Anthony Bush, "The Other Digital Divide: Disparity In the Auction of Wireless Telecommunications," 52 Cath. U. L. Rev. 351 (2003).

III THE COMMISSION SHOULD ADOPT THE BAND OPTIMIZATION PLAN, BUT NOT REVERSE AUCTIONS.

The Public Interest Spectrum Coalition generally supports the "band optimization plan" ("BOP") proposed by Access Spectrum and Pegasus Spectrum. Under this plan, these two companies will release some guardband licenses while consolidating others. The result is a net improvement in spectrum efficiency for the guardband licensees, the public safety spectrum users, the commercial licensees, and the general public. Because the guardband licensees will return licenses, the net improvement in efficiency for private licensees does not constitute an unjust windfall to the private licensees.

Further, even if the net result is to increase the value of the remaining licenses to the guardband licensees by some modest amount greater than the value of the returned licenses, the net benefits to the public of increased spectral efficiency justify adoption of the plan. While the Commission must not take its responsibility to ensure a return to the public on the use of public spectrum assets and avoid unjust enrichments lightly, calculation of what best serves the public interest does not always lend itself to neat mathematical resolution.

On the other hand, PISC opposes any attempt to permit a "reverse auction," as suggested by

some in this proceeding, even if a reverse auction would enhance overall spectral efficiency. Reverse auctions violate the plain language of Section 309(j), which requires that the Commission deposit all revenue from spectrum auctions directly into the U.S. Treasury. 47 U.S.C. §309(j)(8)(A). Nor are reverse auctions necessary to ensure spectral efficiency. Given the small number of guardband licensees, commercial winners of adjacent blocks can negotiate directly to obtain the guardband licenses after the auction.

Finally, PISC reminds the Commission that Congress has not looked kindly on attempts to end-run the requirement of Section 309(j)(8)(A), even where reverse auctions would enhance efficiency and speed the digital transition. In 2002, after the Commission proposed the equivalent of a reverse auction to clear broadcasters from the portion of the analog spectrum set for return (and at issue again here), Congress passed the Auction Reform Act of 2002 and directly prohibited the FCC's proposed reverse auction. Pub. L. 107-195. Given this clear expression of Congressional disapproval for reverse auctions, the Commission should not try to implement such a proposal again.

IV THE COMMISSION MUST BALANCE THE NEED FOR SMALLER LICENSES AGAINST THE NEED TO CREATE NEW NATIONAL COMPETITORS.

With regard to the availability of smaller licenses to promote rural access, PISC generally supports this proposal. At the same time, the Commission must not compromise the ability of new entrants to create national footprints. To the extent this requires trade offs, the Commission can alleviate spectrum shortages in rural areas by approving the Frontline proposal and ensuring the presence of a wireless wholesaler nationally.

History shows that selecting the proper license size often represents a balance of competing interests. On the one hand, many economists blame the smaller license sizes available from the first

PCS auctions for delaying national deployment and driving of rates by providing incentives to rural carriers to charge high roaming fees rather than build out service. *See* Wilkie Auction Analysis (citing sources). On the other hand, rural carriers continue to maintain that without a supply of smaller licenses, they cannot acquire sufficient spectrum to provide service to their communities.

Adopting the precautions against auction manipulation will help alleviate the problem of affordable spectrum for rural carriers. In addition, because of the nature of the spectrum, build out of a somewhat larger service will be cheaper. The physical properties of the spectrum allow service to a much wider area with a smaller number of cell sites, driving down cost significantly. In addition, approval of the Frontline proposal or other open access proposals may provide spectrum for local services more efficiently than numerous licensees. These factors speak against creating too many licenses designed for the benefit of smaller carriers.

At the same time, however, the Commission should ensure that small carriers have a sufficient number of smaller licenses that they can realistically expect to win licenses and meet build out ad service requirements. Local providers are far more likely to serve local communities. In addition, where license areas include dense population centers combined with a population thinly dispersed throughout the remainder of the license area, a real danger exists that the licensee will not serve those outside the most concentrated areas. By contrast, dividing such a region into two licenses ensures that a licensee acquiring the less densely populated region actually intends to serve that region.

Given the complex nature of this calculus, where it appears that the principle of creating sufficient number of small licenses conflicts with providing increased opportunities for a national provider, the need to introduce national level competition should take precedence.

CONCLUSION

The unique nature of the 700 MHZ licenses has prompted parties to present novel and innovative proposals to the Commission, such as the Frontline proposal and the Band Optimization Plan. Unsurprisingly, incumbents have generally responded by urging the Commission to move as swiftly as possible to an auction that would use the same rules that have served the incumbents so well in the past. The Commission must not allow the incumbents to stampede it into a hasty embrace of the *status quo*. Rather, based on the nature of the broadband and wireless markets and the history of FCC auctions to date, the Commission should adopt the bidding rule modifications and the service rule proposals set forth above.

Respectfully submitted,

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April 3, 2007

Attachment A

SPECTRUM AUCTIONS ARE NOT A PANACEA: THEORY AND EVIDENCE OF ANTI-COMPETITIVE AND RENT-SEEKING BEHAVIOR IN FCC RULEMAKINGS AND AUCTION DESIGN

BY

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University of Southern California

March 26, 2007

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EXECUTIVE SUMMARY

This report analyzes a key component of spectrum management policy in the United States. It evaluates the Federal Communications Commission's ("FCC" or "the Commission") policy goals and related mechanisms for achieving efficient spectrum allocation and assignment for commercial use of spectrum. It specifically addresses the potential use competitive bidding auctions, especially in the context of opposing arguments that have been raised against the M2Z Networks Inc. ("M2Z") application for an exclusive license to use 20 MHz of spectrum in the 2.1 GHz band to provide competitive broadband services nationwide.

The FCC's spectrum policy decisions entail much more than meet the eye. At stake are the downstream market structures of a number of market sectors. In particular the telecommunications sector, including fixed and wireless broadband and voice services, as well as broadcasting and media industries and ultimately the Internet and information technology ("IT") sectors, whose future growth is premised on the ability to transmit digital information across multi-modal broadband networks including wireless. Additionally, these policy deliberations entail billions of dollars in transfers from commercial enterprises to consumers through the provisioning of innovative wireless services as well as payments to the United States Treasury.

Given technological and marketplace developments in the telecommunications and broadband sectors, the only currently apparent viable means of new unaffiliated competitive entry is through wireless technologies using spectrum. As such, acquiring

access to spectrum, either through an exclusive license or through some other means such as spectrum commons, has become the first hurdle that any prospective new competitor must address when considering entry. The FCC is the congressionally mandated trustee of this important public asset and is therefore the major arbiter of the competitive outcome in the various downstream telecommunications and broadband markets.

In light of the FCC's power to affect competition and consumer welfare through its spectrum allocation and assignment authority, some vociferously call for spectrum auctions as the only means of assigning spectrum, blindly positing the use of auctions as the panacea for implementing the Commission's obligation to allocate and assign spectrum in the public interest. This paper recognizes the long held truth of the problem of rent-seeking at the FCC but points out that both economic theory and marketplace evidence hold that spectrum auctions are not always a cure since the very processes of designing and conducting auctions at the FCC are prone to anti-competitive rent-seeking behavior by entrenched market actors. In the case presented in M2Z's license application, given the goals set forth by Congress and the history of spectrum auctions, the FCC should avoid short-circuiting Congress' mandate and hold true to its mission by assigning this band of spectrum in the public interest after a vigorous and transparent debate on the merits of valid proposals it receives.

BACKGROUND

Today's telecommunications sector presents a high degree of concentration. In the wireless sector we have four major national competitors and the broadband access market is even more concentrated. The residential broadband access market is effectively a duopoly where cable operators compete with incumbent LECs. As such, competitive

market forces are stymied resulting in higher prices, less investment and less innovation to bring consumers better and more affordable services. In short, consumers are getting shortchanged.

Having left command and control mechanisms to correct market failures behind, the FCC should focus on promoting facilities based entry. It is in this context that policy makers should evaluate the merits and failures of spectrum allocation policy. In particular policy makers must take into account that spectrum allocation does not happen in a vacuum. Various incumbent players in the sector, both providers of fixed and mobile as well as wired or wireless telecommunication services, have strong incentives to influence this process to their benefit for two reasons: first, because they may want access to more spectrum in order to expand their services, and, second, because through the political process they may be able to limit or delay entry of potential competitors who might make use of the spectrum. The latter incentive may be even stronger today than in the past if potential entry into the national market using new technologies with significantly lower marginal costs of network deployment and/or the possibility for product differentiation (such as nomadic broadband services) could accelerate depreciation schedules of existing incumbent's network infrastructures.

Firms with such powerful incentives to delay or deter new entry find the means to do so through the current spectrum allocation rulemaking process managed by the FCC and, in cases where there is competitive bidding, through the auction process itself. There are four key tactics whereby firms can potentially influence the process and outcome in anti-competitive ways:

- Strategically warehousing spectrum in order to prevent entry for potential competitors;
- Delaying the decision-making process through long-drawn debates over service rules, un-specifiable and unquantifiable arguments of technical interference and other means;
- Outbidding new entrants in unfettered auctions that do not expressly address the risk of incumbent carriers' potentially anti-competitive tactics;
- Slicing new available bands for private commercial use in ways that make it more costly or impossible to build out upon such license a viable national competitive business plans.

In this report I also analyze the possibility of anti-competitive behavior in FCC spectrum auctions. Many commentators in the debate over spectrum management cling to the idea that auctions will resolve market failures in the spectrum allocation process. The general consensus suggests that such a mechanism will do away with rent-seeking strategic behavior that is induced by command and control allocation mechanisms. Furthermore, auctions will provide a transparent, level playing field where all parties that have a stake in the sector can compete for the asset with equal footing.

To some extent this is true. From an economic perspective, the use of auctions can be an effective and transparent market-based mechanism to assign scarce spectrum resources across competing private applications. However, as I argue in this report, in the case of spectrum management, where there exist strategic incentives to use the rulemaking process and auction process anti-competitively by incumbent carriers seeking to curtail or slow entry, auction mechanisms can result in socially suboptimal outcomes and even constitute a *de facto* barrier to entry that impairs competition. This can be

demonstrated, as I do in this report, from a theoretical standpoint as well as given the evidence on the record.

The theory of auctions has recently developed new insights showing that auctions, under various circumstances that directly apply to spectrum allocation may not achieve an efficient allocation outcome (granting licenses to private users that will achieve the highest social benefits from the asset), or revenue maximization properties. In particular, bidders' valuation of spectrum assets present three properties that imply that FCC auctions theoretically may not achieve efficient outcomes: multidimensional private valuations, combinatorial valuations, exacerbated by the common practice of arranging blocks of spectrum into artificially constructed discrete geographical licenses that bare no resemblance to geographic product markets, and externalities across bidders valuations, which induce incumbent carriers to outbid potential new entrants into the competitive arena.

In other words, economic theory today tells us that, when valuation-externalities are present, such as those commonly present in spectrum auctions, every auction mechanism is either inefficient or manipulable. Thus, the naive belief that spectrum auctions are always the most efficient and effective solution to the social allocation of resources as matter of economic theory is in error.

In this report I examine evidence of past FCC Simultaneous Multiple-Round auctions and test whether these undesirable theoretical conclusions can be supported by the facts and conclude that, in some cases, they are. I, therefore, conclude that arguments by M2Z's opponents that rule out the grant of M2Z's license Application on *a priori*

efficiency or non-discrimination grounds are not well-founded because several previous auctions fail these same tests.

I. QUALIFICATIONS AND INTRODUCTION

My name is Simon J. Wilkie. I am Executive Director of the Center for Communications Law and Policy and Professor of Economics at the University of Southern California. I am also an Affiliate of the ERS Group, an economics and financial consulting firm. From 2002 to 2003, I served as Chief Economist at the Federal Communications Commission ("FCC" or "Commission"). In that capacity, I oversaw the economic analysis performed by the Commission staff and advised the Chairman and Commissioners on issues involving economic analysis. Major items before the FCC during my tenure included the EchoStar/DirecTV transaction, the Comcast/AT&T Broadband transaction, the Triennial Review of Unbundling Obligations, and the Biennial Review of Media Ownership rules.

Previously, I was an Assistant Professor and Senior Research Associate in Economics at the California Institute of Technology. Prior to joining the faculty at the California Institute of Technology, I was a Member of Technical Staff at Bell Communications Research. I have also held the positions of Affiliated Scholar of the Milken Institute and Visiting Assistant Professor at Columbia University. Over the past fifteen years, my academic research has focused on the areas of mechanism design, regulation, and game theory. I specialize in analyses involving industrial organization, regulation, public finance, and the design of institutions, with particular applications to the economics of telecommunications and network industries. I have conducted economic research and prepared testimony on a variety of antitrust and regulatory issues

in a number of industries, including the telecommunications industry. I have also consulted on matters involving mergers and acquisitions in the satellite and the cable industries, and on issues related to local service and wireless competition. My research has appeared in a number of academic journals, including the *Review of Economic Studies*, *The Journal of Economic Theory*, *The Journal of Economics and Management Strategy*, and *The Journal of Industrial Economics.* I received a Bachelor of Commerce degree (Honors) in Economics from the University of South Wales, Australia, and my M.A. and Ph.D. degrees in Economics are from the University of Rochester.

I have been asked by M2Z to examine various issues of spectrum management policy in the United States and evaluate how they are likely to affect M2Z's Application for a national 20 MHz license to provide wireless broadband service.[1] This paper is organized as follows: In Section II, I introduce key issues in spectrum management policy and their interaction with M2Z's Application. In Section III, I examine the likelihood of warehousing behavior by incumbent carriers and describe cases on the record of such behavior. In Section IV, I address the historical procedural delays in the FCC procedure of bringing to market new available spectrum for private commercial wireless services and discuss the effects of such delays upon potential new competitors' costs of acquiring spectrum and entering the downstream associated markets. In Section V, I analyze inefficiencies under the competitive bidding process stemming from discrepancies between private bidders' valuations of the spectrum asset and social

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[1] See, M2Z Networks Inc., APPLICATION FOR LICENSE AND AUTHORITY TO PROVIDE NATIONAL BROADBAND RADIO SERVICE IN THE 2155-2175 MHZ BAND, Amended on September 1, 2006, hereinafter "M2Z's Application" or "M2Z's Proposal", available at http://www.m2znetworks.com/xres/uploads/documents/M2Z-Amended-Application.pdf (website visited on January 29, 2007).

welfare benefits accruing in the market. I further discuss the implications from such auctions upon new entrants' ability to gain access to the market when competing directly for spectrum licenses with incumbent players. In Section VI, I contrast two alternative means of allocating spectrum through auctions and via royalty mechanism payments. My *Curriculum* Vitae is included as an Annex.

II. KEY ISSUES IN SPECTRUM ALLOCATION AND ASSIGNMENT POLICY

One of the key debates of spectrum allocation policy today is how to allocate and assign scarce resources across competing private interests in order to enable and promote the best use for society of these valuable public assets. Historically, the mechanism relied upon was command and control by different government agencies. But today the general consensus is that market-based mechanisms with minimum discretion of the FCC or other government agencies are the best option. Such processes, the theory goes, would allow the most efficient usage of the assets, minimize the pitfalls of political rent-seeking activities, and ameliorate the need for timely decision-making process regarding technological and commercial applications associated with the spectrum. Following this logic, we must first ask what are the goals that public policy should aim at when designing spectrum policy and, second, what are the best mechanisms to achieve such goals. To answer these questions, we must examine the situation in the telecommunications industry today and the role that spectrum policy plays.

One of the goals of telecommunications public policy is to improve social welfare by promoting a balance of bargaining power across consumers and suppliers of telecommunications services. This can be achieved by promoting competition as a means to provide alternative suppliers of differentiated services to consumers and the right incentives for suppliers to invest in more efficient and better products. Short of discredited command and control strategies, the main mechanism for policy makers to

ensure that this process takes places is by discouraging any anti-competitive activities by different market players and, crucially, by promoting entry into the market.

Given the current state of technological and marketplace developments in the broadband sector, the main viable means of entry for the provision of broadband services is through wireless technologies. Thus, obtaining a spectrum license has become the first hurdle that any prospective new competitor must address when considering entry. The FCC, as the trustee of this public resource and key competitive asset, has the sole national responsibility for determining spectrum allocation and assignment making it the major arbiter of the competitive outcome in the various downstream telecommunications markets.

Many players are choosing to frame the key debate concerning spectrum policy in terms of what is the best mechanism for assigning these scarce resources. This is indeed the case in the context of the M2Z Application for a spectrum license, where opposing opinions are framing the debate around the issue of auctions. Of the nine filings in the record as of March 15th that petition to deny M2Z's Application, all but one cite as a key argument the "need" to place the 20 MHz that M2Z seeks in the market via competitive bidding.[2] CTIA goes as far as to claim that "[t]he public interest would not be served if

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[2] See AT&T Inc., Petition to Deny, WT Docket No. 07-16 (submitted Mar. 2, 2007) ("AT&T Petition to Deny"); CTIA – The Wireless Association, Petition to Deny, WT Docket No. 07-16 (submitted Mar. 2, 2007) ("CTIA Petition to Deny"); Petition to Deny of Motorola, Inc., WT Docket No. 07-16 (submitted Mar. 2, 2007) ("Motorola Petition to Deny"); NextWave Broadband Inc., Petition to Deny, WT Docket No. 07-16 (submitted Mar. 2, 2007) ("NextWave Petition to Deny"); Petition to Deny of T-Mobile USA, Inc., WT Docket No. 07-16 (submitted Mar. 2, 2007) ("T-Mobile Petition to Deny"); Petition to Deny of Verizon Wireless, WT Docket No. 07-16 (submitted Mar. 2, 2007) ("Verizon Wireless Petition to Deny"); Wireless Communications Association International, Inc., Petition to Deny, WT Docket No. 07-16 (submitted Mar. 2, 2007) ("WCA Petition to Deny"); Comments of the Consumer Electronics Association, WT Docket No.

the Commission assigned spectrum to M2Z without holding an open, competitive auction."[3]

In my opinion, these claims are misguided and drive the debate away from the critical social policy issue that M2Z's Application raises. Though the mechanism by which spectrum assets are assigned in the private market is, indeed, important to the debate, it is secondary to the policy issue of what is the best use for this and other spectrum bands that are currently underutilized.

In today's telecommunications market, after a process of incumbent consolidation, policy makers should, in my opinion, be foremost concerned with promoting competition in the market and providing incentives for further deployment of new technologies and entry of new players. If these are worthy policy goals, the debate surrounding spectrum management policy, whether in the context of M2Z's Application or elsewhere, should address the question of how best to ensure that new entrants into the telecommunications market have a realistic chance of acquiring the needed spectrum to start their business ventures. Failure to do so would defeat the public policy goal of promoting social welfare. Furthermore, failure to do so would be contrary to statutory directive.

Section 309(j)(3) of the Telecommunications Act of 1996 is clear on this point. While directing the design of competitive bidding as a mechanism to assign spectrum resources across mutually exclusive commercial proposals, legislators have directed the

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07-.16 (submitted Mar. 2, 2007) ("CEA Comments"); Opposition of EchoStar Satellite L.L.C., WT Docket No. 07-16, at 1–2 (submitted Mar. 2, 2007) ("EchoStar Opposition").

[3] CTIA Petition to Deny, at 4.

Commission to "include safeguards to protect the public interest in the use of the spectrum"[4] with, among others, the following objectives:

a. "promoting economic opportunity and competition;"
b. "ensuring that new and innovative technologies are readily accessible to the American people by avoiding excessive concentration of licenses;" and
c. "by disseminating licenses among a wide variety of applicants including small businesses, rural telephone companies, and businesses owned by members of minority groups and women."[5]

In order to address these concerns, policy makers must take into account that spectrum allocation and assignment does not happen in a vacuum. The stakes deriving from spectrum management are high and, therefore, there is a need for a transparent and vigorous political process to shape the debate because it is evident that different interests are attempting to leverage their power to best serve their interests.

Incumbent players in the sector, both providers of fixed and mobile, wire or wireless telecommunication services, have strong incentives to influence this process to their benefit for two reasons: first, because they may need access to more spectrum in order to expand their services, and, second, because through the regulatory process they may be able to limit or delay entry of potential competitors. These incentives may be even stronger today than in the past if potential entry into the national market using new

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[4] See § 309(j)(3) of the Telecom Act of 1996, Pub. L. No. 104-104, 110 Stat. 153 (1996), 47 U.S.C. ("Telecom Act 96").

[5] See Telecom Act 96 § 309(j)(3)(B).

technologies with significantly lower marginal costs of network deployment and/or the possibility for product differentiation (such as nomadic broadband services) could accelerate depreciation schedules of existing incumbent's network infrastructures.

The policymaking process surrounding M2Z's proposal is one example where this type of anti-competitive behavior might emerge. M2Z's business plan proposes to deploy a wireless broadband network using World Interoperability for Microwave Access ("WiMax") technology utilizing the 2155-2175 MHz frequency band to provide mobile nomadic broadband services.[6] According to its business plan, M2Z's service would comprise of (1) free nomadic broadband service to be financed via advertising revenues and (2) a paid subscription broadband service with faster (3 Mbps) data transfer rates.[7] If M2Z is successful in its application process, such a business proposal could have dramatic effects upon the competitive dynamic in the market, significantly impacting incumbent carriers' future stream of revenues and business plans and, ultimately providing cheaper and better services for consumers. The incentives for incumbents to take preemptive action, therefore, exist. Furthermore, incumbents are typically less cash constrained than potential entrants, face lower risks in the post-entry market dynamics, do not face the challenge of entering a relatively mature market where customer switching costs are high and, generally, have the financial means to outbid new entrants in an unfettered competitive bidding process. Applications for spectrum by new entrants such as M2Z should be evaluated keeping in mind the potential pitfalls deriving from unfettered rent-seeking strategic behavior by existing market players.

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[6] See M2Z's Application.

[7] Id.

Firms with such powerful incentives to delay or deter new entry find the means to do so through the spectrum allocation rulemaking process managed by the FCC and, in cases where there is competitive bidding, through the auction process itself. There are four key tactics whereby firms can potentially influence the process and outcome in anti-competitive ways:

- Strategically warehousing spectrum in order to prevent entry for potential competitors;
- Delaying the decision-making process through long-drawn debates over service rules, un-specifiable and unquantifiable arguments of technical interference, and/or other means;
- Outbidding new entrants in unfettered auctions that do not expressly address the risk of incumbent carriers' potentially anti-competitive tactics;
- Slicing new available bands for private commercial use in ways that make it more costly or impossible to build upon such license a viable national competitive business plan.

As I describe below, this type of behavior has taken place in the past and will continue to do so in the future unless policy makers specifically take into account the potential for strategic preemptive actions by incumbent players, not just within the bidding process of an auction but also throughout the rulemaking process that gets us to that point.

All of this should frame a policy debate of how to prevent anti-competitive rent-seeking activities by incumbents and others not only within the actual mechanism for allocating spectrum (auctions or otherwise), but throughout the political process of policy debate and rulemaking for allocating and assigning spectrum. As I argue in the ensuing body of this report, a simple reliance in competitive bidding mechanisms, such as

auctions, will not solve the main underlying problem that spectrum policy should be concerned with.

In order to address potential anti-competitive behavior and promote the most efficient use of the scarce resource, spectrum policymakers should incorporate mechanisms specifically designed to promote and nurture rapid entry into the market by potential new competitors. There are a number of well-tested means to do so, such as the introduction of spectrum caps within the service rules of new blocks available for commercial use. In order to limit speculative investments and warehousing behavior by new or incumbent players, restrictions for bidding for new available blocks could be imposed on firms that hold spectrum but have failed to make commercial use of it within a specified service rules timeframe.

III. THE RISK OF WAREHOUSING BEHAVIOR BY INCUMBENT PLAYERS

Competitive bidding processes without a mechanism to prevent warehousing behavior that would prevent incumbent carriers from preempting competition from new entrants would amount to an unfair advantage to incumbent carriers, stifle the competitive process and harm consumers.

A. THE THEORY

Economists have long been concerned with the possibility of established firms acting strategically to delay or prevent entry into the market by new potential competitors. The theory of strategic competition is rich in examples analyzing necessary conditions under which incumbent firms' incentives are such that they may profitably engage in strategic behavior to affect potential rival's demand or cost structures, thus making entry less appealing or all together unprofitable.

In the 1950s, industrial economist Joe Bain[8] first proposed the theory of the assumption of limit pricing behavior whereby incumbent entrants would increase their pre-entry output (and reduce prices) in order to affect potential entrants' residual demand and discourage entry. The idea was received with skepticism by many economists and sparked a volume of literature analyzing incumbents' strategic behavior when faced with potential entry.

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[8] See Joe Bain, Barriers to New Entry, Harvard Univ. Press, 1956.

The basic premise of this literature is that, when faced with the possibility of entry, an incumbent's pre-entry strategic decisions to prevent entry (limiting price and increasing output, engaging in strategic over-capacity investment, etc.) would only be credible if its long run profits derived from such decisions were higher than profits under the alternative scenario, where entry takes place and incumbent's strategic behavior accommodates accordingly. One of the basic conclusions of this literature is that theoretical assumptions of what incumbents might do prior to a competitor's entry could not be analyzed in isolation. To be credible, economic models had to contrast the profitability of such behavior with the alternative scenario where entry does occur. This is so, because, if entry were to occur, rational incumbents would adapt their market strategies to the new circumstances by reducing output and adjusting their competitive behavior.[9] Viewed as a sequential decision process, the ability of an incumbent to credibly act strategically prior to entry in order to prevent entry was thought to be less likely than earlier economists had postulated.

However, scholars of strategic firm behavior concluded that credible entry deterring strategies might be possible in circumstances when pre-entry decisions affected long run expected demand or cost. In particular, engaging in strategic activities that lowered the incumbent's marginal costs (for example, by investing in strategic capacity

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[9] One of two forms of competition is generally assumed—either "Bertrand" competition or "Cournot" competition, named after the 19th Century French economists who developed the theories. Under Cournot competition, a firm chooses to produce the amount of output that maximizes its profits. Equilibrium is reached when the level of each firm's output is such that it could not earn higher profits by changing its output decision when taking its competitors' output decisions as fixed. Under Bertrand competition, firms compete by setting prices that maximize the firms' individual profits. Equilibrium under Bertrand competition is reached when no firm could earn higher profits by changing its prices when it takes its competitors prices as fixed. See Jean Tirole, The Theory of Industrial Organization. Cambridge: The MIT Press, 1988 at 209-12; 218-23.

beyond pre-entry optimal levels) could have credible deterring effects if the new entrant could assume that it would not be able to reach a level of economies of scale that would allow it to compete profitably with the incumbent carrier under its new, post-strategic capacity build-out, cost structures.[10] Alternatively, strategic actions that would result in a sustainable increase of rivals' costs in the event of entry could effectively deter such entry (for example, strategically using labor bargaining to increase the cost of labor within the sector and provide a comparative advantage to the firm with less-labor intensive production processes).[11]

It is in the context of raising rivals' costs that strategic behavior through competitive bidding for spectrum should be examined. The rich literature briefly summarized above is generally skeptical of the ability of any one firm or group of firms to credibly sustain strategic behavior that would prevent entry. If entry does occur, the theory generally concludes, an incumbent carrier would adjust its market behavior (pricing, capacity build out, etc.) to the new circumstances by engaging in optimal strategies when faced with the new competition. In short, in a market where entry and exit barriers are relatively low, the ability of incumbent carriers to, prior to actual entry taking place, strategically affect demand or cost structures in the *ex post* scenario where entry had occurred, is generally limited.

However, this theory assumes that the ability of incumbent firms to affect entry costs is only possible on the margin. This assumption fails in the context of services that

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[10] See Avinash Dixit, "The Role of Investment in Entry Deterrence," Economic Journal 90 (1980).

[11] See Steven C. Salop and David T. Scheffman, "Raising Rivals Costs," American Economic Review 73 (May 1983).

include as a key complement for their production scarce spectrum. Electromagnetic spectrum is a key component in the production of wireless services (mobile, fixed or otherwise). Entry into the market for the provision of wireless services must first and foremost pass the hurdle of acquiring the necessary spectrum (usually in exclusivity when large sunk network investments are necessary to provide the final service) to provide the service. In short, the telecommunications sector today presents a discrete significant hurdle to entry in the form of spectrum licenses, where the FCC is the unique gate-keeper of this scarce asset and there is a process in place by which potential entrants can access that resource. And it is that very process that potentially affords incumbent players the possibility of raising potential rivals' costs or *de facto* preventing entry from potential competitors.

Given the auction process and in the absence of limits to incumbent firm participation (such as the spectrum caps that were imposed on incumbent carriers in the 1993-2003 PCS spectrum auctions), incumbent carriers can effectively increase rivals' costs by pushing up the price of the spectrum license at auction. In this way they can increase the new entrants' sunk entry investment and potentially affect the marginal costs of entrants by inducing higher capital costs. Furthermore, and given the scarcity of available spectrum for commercial ventures, incumbent carriers could foreclose market entry altogether by acquiring the new available spectrum not for the purpose of expanding their own infrastructures, but in order to prevent others from using it. This is generally referred to in the industry as "warehousing" and as I delineate below, there is evidence in the record that this type of behavior has taken place in the past.

Unlike in the many cases analyzed by the literature described above, the telecommunications market today does presents a viable mechanism by which incumbents *could* raise rival costs at entry or strategically bar entry altogether. From an economic standpoint then, the question remains as to whether incumbents *would* engage in such strategic behavior. In other words, following the economic logic analyzed in the literature, would incumbent firms find such pre-entry strategic behavior profitable in the long run and under alternative entry contingency cases?

In the case of warehousing to prevent potential competitors from using that spectrum to enter the market, the strategic entry-deterring behavior would be profitable for the incumbents if the price paid for the spectrum is lower than their loss of profit derived from increased competition in the downstream markets (which, depending on what technology and business plan is chosen, could be the market for the provision of mobile services, fixed broadband services, nomadic services, satellite services, other wireless services or all of the above). This depends on a number of factors including the price paid for the warehoused spectrum and the impact upon the downstream market from competitive entrants using that spectrum. That impact depends on a number of factors including existing competition in the downstream markets and dynamic forces from converging sectors.

B. A SIMPLE ECONOMIC MODEL

The following example highlights the inherent bias against entrants. Consider a simple market with an incumbent monopolist and a new license being auctioned. Firm values and consumer values are represented below:

Market Structure	Incumbent's Profits	Entrant's Profits	Consumer Surplus	Social Surplus
Monopoly	50	0	25	75
Duopoly	10	10	80	100

Notice that the socially efficient outcome and that which maximizes consumer welfare is under entry, with a social surplus of 100. However, an entrant will be willing to spend no more than 10 in an auction to acquire a license, while an incumbent will be willing to spend up the difference in its profits, i.e., 40, (that is 50 minus 10), to deter entry. Thus the incumbent will outbid the entrant in an auction and the outcome is inefficient.

It is of course not always the case that incumbents will outbid entrants. Indeed, the more competitive the current market structure is the smaller the incentive and ability of an incumbent to foreclose entry is. The analytics of the trade off can be seen in the following simple Cournot model.[12]

Suppose that there is a single market and price determined by the current quantity of spectrum available for use in the private market. That is, there is a demand curve *P(Q)* where *Q* is total spectrum quantity made available. And suppose there is a total capacity K of spectrum in the market where there are N incumbent firms and each incumbent firm 1,2,3… N has available capacity (through its licenses) *k1, k2 , k3 ….kN.* Initially, assuming that the incumbents use all of their capacity, the market price of spectrum will depend on the total available spectrum capacity K and is given by *P1= P(K).* Suppose

[12] For the general case see Jeheil P. and B. Moldovanu (2000) "Auctions with Downstream Interaction among Buyers," Rand J. of Econ. Vol 31. Pp. 768-791.

now that a new license of size $L<K$ becomes available. With competitive entry the new price will be a function of the total new capacity $L+K$ and given by $P2= P(K+L)$. Suppose that for simplicity marginal costs are zero and all costs are sunk. Then an entrant will be willing to pay up to $(P2-c)L-S$. Where S is the level of sunk costs incurred to deploy the service, c is marginal cost and $P2L$ is the entrant's revenue. The effect of entry on an incumbent is depressed operating profits **(**$P1-c)ki$ to $(P2-c)ki$. Thus incumbent "i" loses $(P1-P2)ki$ from entry.

If an incumbent were to use the license then its revenues would be $P(ki+L)$. If $(P1-c)ki > (P2-c)(ki+L)$ or if $(P1-P2)ki > (P2-c)L$ then it is more valuable for an incumbent with capacity ki to warehouse the spectrum if they win the auction. It is profit maximizing for an incumbent to outbid the entrant if $(P2-c)(L)-Si> (P2-c)L-S$, where Si denotes additional sunk costs of the incumbent. If incumbent sunk costs are zero, then the incumbent will always outbid the entrant. Thus, an incumbent will have the incentive and ability to outbid the entrant and warehouse the spectrum if: $(P1-P2)ki > (P2-c)L$.

Because the second inequality holds whenever the first one does, we just have to verify observation of the first inequality to ascertain under what conditions incumbents will have an incentive to warehouse spectrum. Now because K is the initial quantity in the market and L is the change in quantity we can rewrite this condition by dividing each side by $P2L$. Using the elasticity of demand, simple algebra reveals that the first inequality holds whenever $e(ki/K) >1, e \bullet m$, where e denotes the elasticity of demand and m is the industry profit margin. That is, incumbents will outbid entrants and warehouse the spectrum when their market share exceeds the markup (or Lerner Index) multiplied by the elasticity of demand. If the elasticity of demand is 0.8, and the markup is 0.4, then

any incumbent with 32% of the current market or more would have the incentive and ability to outbid any entrant and warehouse the spectrum.

According to the latest FCC CMRS report and using the DOJ/FTC standards, the current CMRS industry is highly concentrated. In addition, the service that M2Z plans to deploy will not be "mobile" but rather a "nomadic" broadband service most directly competing with fixed residential broadband service. This market is even more concentrated than the CMRS industry. At present, it is a duopoly in most geographic markets with consumers having only a choice between cable modem and DSL, both provided by incumbent carriers that actively bid in FCC spectrum auctions.[13] Thus, in an open auction, current market structures suggest that incumbent broadband providers and the largest CMRS operators would have the incentive to outbid new entrants and foreclose entry.

C. WAREHOUSING BEHAVIOR IN TODAY'S TELECOMMUNICATIONS MARKET

Warehousing behavior by incumbent players is a reality in today's telecommunications market. Experts in the field have long recognized that this behavior can and does take place. In 2001, 37 economists, among them members of some of the

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[13] There appears to be a "cable and telephone broadband duopoly" in the U.S. according to the CRS Report for Congress, Order Code RL33496, Access to Broadband Networks, Updated August 31, 2006, at 17. Furthermore, according to the most recent FCC report pertaining to High-Speed Services for Internet Access, out of a total of 64,614,270 high-speed lines, 60,496,807 were provided by RBOCs, other ILECs, and cable modem providers. See, FCC, Wireline Competition Bureau, Industry Analysis and Technology Division, HIGH-SPEED SERVICES FOR INTERNET ACCESS: STATUS AS OF JUNE 30, 2006, January 2007, Table 6.

nation's most respected academic and research institutions, Nobel laureates and some who previously served at the White House, the Federal Trade Commission, the Department of Justice, and the FCC itself, addressed the possibility of warehousing for strategic reasons in cases where "withholding spectrum access is an exercise of market power."[14]

To prevent such anti-competitive activities, they recommended the use of competition policy and the liberalization of secondary market restrictions (allowing licensees to lease access to spectrum usage of the licenses they hold). Such policies, they argued, would introduce market forces into the decision process of existing license holders that would provide incentive in the market place to make more efficient use of existing spectrum in the private realm. While I advocate the implementation of such policies, until such a time where they are effectively in place, the potential for such anti-competitive opportunistic behavior should shape the decision process of assigning newly available spectrum to private parties and, particularly, where new entry is a policy objective and is deemed positive for the public good. As stated in the introduction to the 2001 statement, such a practice would be consistent with the Telecommunications Act of 1996's explicit mandate on the use of competitive bidding under Section 309(j)(3)(B), which calls for "promoting economic opportunity and competition and ensuring that new and innovative technologies are readily accessible to the American people by avoiding excessive concentration of licenses and by disseminating licenses among a wide variety

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[14] See, "Comments of 37 Concerned Economists" in the Matter of Promoting Efficient use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets, WT Docket No. 00-230, February 7th, 2001, at 6, available at:

http://www.aei-brookings.org/admin/authorpdfs/page.php?id=417 (website visited on March 13th, 2007).

of applicants, including small businesses, rural telephone companies, and businesses owned by members of minority groups and women."[15]

D. EVIDENCE ON THE RECORD OF WAREHOUSING BEHAVIOR BY INCUMBENT PLAYERS

1. Warehousing in the WCS Band

The 2.3 GHz Wireless Communications Services ("WCS") band is an example of warehousing behavior where valuable spectrum held by incumbent telecommunication players for broadband services and wireless services remains un-used or under-used. The WCS licenses were granted in April of 1997 through an auction process to grant licenses for 30 MHz of spectrum in the 2.3 GHz band (Auction 14).[16] On July 21, 1997, the Commission granted 126 WCS 10-year licenses to operate in the 2305-2320 MHz and 2345-2360 MHz frequency bands.[17]

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[15] 47 U.S.C. § 309(j)(3)(B).

[16] See WCS Auction Closes; Winning Bidders in the Auction of 128 Wireless Communications Services Licenses, Public Notice, DA 97-886 (April 28, 1997).

[17] FCC Announces the Grant of Wireless Communications Service ("WCS") Licenses, Balance of Winning Bids are Due by August 4, 1997, Public Notice, 13 FCC Rcd 4782 (1997).

The WCS band can be used to provide wireless broadband services, including services provided by WiMax technology,[18] that would compete directly against cable modem and DSL services, offered by incumbent LECs and cable operators through their fixed networks.[19] Flexible build-out schedules were required under the license concessions to be met by July 27, 2007, in order to "promote efficient use of the spectrum, encourage the provision of service to rural, remote and insular areas *and prevent the warehousing of spectrum*" (emphasis added).[20] Failure by a WCS licensee to meet the construction requirement would result in forfeiture of the license.[21]

Notwithstanding these requirements, the spectrum has remained under-used due to the failure of the carriers to build-out wireless network infrastructures using these bands.[22] Recognizing their failure to meet such requirements, in June of 2006 a coalition of WCS licensees including AT&T, BellSouth, Comcast Corporation, NextWave, NTELOS, Sprint-Nextel, Verizon and WaveTel NC requested an extension of deadline for compliance with network deployment requirements. The coalition also requested that the FCC conditionally renew WCS licenses at the July 2007 renewal date, subject to a

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[18] See Consolidated Request of the WCS Coalition For Limited Waiver of Construction Deadline for 132 WCS Licenses, Order, 21 FCC Rcd 14134 (Wireless Telecom Bur. rel. Dec. 1, 2006), at 8.

[19] See, Wireless Communications Service (WCS) FCC home page available at: http://wireless.fcc.gov/services/index.htm?job=service_home&id=wcs (website visited on March 14th 2007).

[20] See WCS Report and Order, 12 FCC Rcd at 10843 ¶ 111.

[21] See WCS Report and Order, 12 FCC Rcd at 10843 ¶ 113; 47 C.F.R. §§ 27.14 (a).

[22] The AT&T licenses were previously held by various subsidiaries of AT&T Wireless and Cingular Wireless. Verizon assigned its WCS licenses to Horizon Wi-Com LLC in August 2006.

showing of substantial service in July 2010.[23] The FCC granted the request on December 1st, 2006[24] arguing that "[t]he extension of the construction deadline until July 21, 2010, is intended to give WCS licensees additional flexibility to develop equipment and to deploy services based on opportunities available to them in the near future."[25]

2. Unused Spectrum by ILEC BellSouth Later Divested by AT&T

On December 28, 2006, as part of the AT&T-BellSouth merger commitments, AT&T voluntarily agreed to divest all of the spectrum that BellSouth held in the 2.5 GHz BRS/EBS band.[26] This decision was based, in part, on the arguments presented by various parties during the merger procedure, in particular, the Clearwire Corporation

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[23] See Consolidated Request of the WCS Coalition For Limited Waiver of Construction Deadline for 132 WCS Licenses, Order, 21 FCC Rcd 14134 (Wireless Telecom Bur. rel. Dec. 1, 2006)

The WCS Coalition was made up of eight companies that indirectly held the majority of WCS licenses authorized to operate within the continental United States: AT&T, Inc., BellSouth Corporation, Comcast Corporation, NextWave Broadband Inc., NTELOS, Inc., Sprint Nextel Corporation, Verizon Laboratories Inc., and WaveTel NC License Corporation.

[24] See, "ORDER In the Matter of Consolidated Request of the WCS Coalition For Limited Waiver of Construction Deadline for 132 WCS Licenses, Request of WCS Wireless, LLC for Limited Waiver of Construction Deadline for 16 WCS Licenses, Request of Cellutec, Inc. for Limited Waiver Of Construction Deadlines for Stations KNLB242 and KNLB216 in Guam/Northern Mariana and American Samoa." WT Docket No. 06-102.

[25] See, "ORDER In the Matter of Consolidated Request of the WCS Coalition For Limited Waiver of Construction Deadline for 132 WCS Licenses, Request of WCS Wireless, LLC for Limited Waiver of Construction Deadline for 16 WCS Licenses, Request of Cellutec, Inc. for Limited Waiver Of Construction Deadlines for Stations KNLB242 and KNLB216 in Guam/Northern Mariana and American Samoa." WT Docket No. 06-102. ¶ 13.

[26] See Review of AT&T Inc. and BellSouth Corp. Application for Consent to Transfer of Control, Ex Parte Notice from Robert W. Quinn, Jr. to Marlene H. Dortch, WC Docket No. 06-74, at 10 (filed. Dec. 28, 2006). It also agreed, as a condition of the merger, to certain construction requirements regarding its 2.3 GHz WCS licenses. Ironically, BellSouth agreed to divest its 2.5 GHz licenses to Clearwire in a $300 million transaction pending approval of the transfer of licenses by the FCC. See "Southeast Spectrum Grab, WiMax carrier Clearwire snaps AT&T's 2.5 GHz spectrum for $300 million," by Colin Gibs, February 24, 2007, available at: http://www.rcrnews.com/apps/pbcs.dll/article?AID=/20070224/sub.

("Clearwire") petition to deny the merger or condition the consent arguing that "[w]ith the acquisition of BellSouth, AT&T will not only gain unprecedented control over several major overlapping wireline and wireless means of providing broadband connectivity and services to consumers and small businesses, but *will also obtain enough spectrum to impede rapidly emerging wireless broadband networks from competing nationwide against AT&T in a key band*."(emphasis added). [27]

Clearwire laid out the holdings that AT&T would control if the merger were approved without conditions, listing the following:

> "(a) the largest wireline network with a much larger footprint with the addition of BellSouth's network;
>
> "(b) a nationwide PCS network providing mobile wireless broadband;
>
> "(c) an almost national footprint in the WCS (2.3 GHz) band which is suitable for WiMax- enabled wireless broadband service after consolidating BellSouth's licenses with AT&T's holdings; and
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> "(d) BellSouth's licenses and leases of 2.5 GHz BRS/EBS spectrum, in locations like Atlanta, New Orleans and other key southeast markets, *which are sufficient to impede the rapid development of nationwide WiMax-enabled wireless networks in competition with each of AT&T's broadband options.*" (emphasis in the original).[28]

It light of these multiple inter-modal means to provide broadband and telephony services via wire and wireless access, Clearwire argued that "[*t]he merger will allow AT&T to delay or obstruct vital nationwide competition from highly capable and rapidly emerging independent broadband wireless platforms that can compete against it intermodally and intramodally, by providing nomadic, eventually fully mobile, wireless broadband service*. […] Unlike AT&T, competitors like Clearwire have no conflicting

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[27] See Petition to Deny or, in the Alternative, to Condition Consent, Clearwire Corporation, in the Matter of BellSouth Corporation and AT&T Inc. Application for Consent to Transfer Control. WC Docket no. 06-74, ("Clearwire Petition to Deny") at ii.

[28] Id. at ii.

interest in protecting other overlapping broadband networks and services, and have every incentive to use this competitive and potentially disruptive independent platform to the fullest extent possible to benefit consumers. However, AT&T will hold enough spectrum to impede promising platforms in that band from providing nationwide broadband service." (emphasis added).[29]

Clearwire concluded that "[i]n a deregulatory environment, where broadband platforms may not be obliged to provide nondiscriminatory service, it is particularly important to have multiple independent competing broadband networks from which consumers can choose. Providers controlling several overlapping broadband distribution platforms may have incentives to take the same approach toward discrimination as each other, and apply it across each of their individual platforms. *This makes it particularly important not to put AT&T in the position of being able to impede independent nationwide mobile wireless broadband platforms in the 2.5 GHz band. AT&T also will have the incentive to warehouse or otherwise use spectrum at 2.5 GHz to avoid losing business in the services that would ride on competing independent broadband platforms*." (emphasis added).[30]

And, furthermore, Clearwire argued that:

> "With unfettered control over large overlapping broadband wireline and wireless platforms, and a nearly nationwide footprint at 2.3 GHz, AT&T will have an enhanced incentive and ability to impede the development of independent facilities-based competition for the delivery of nationwide mobile wireless broadband access services in the 2.5 GHz band. With all of these broadband platforms and other wireless licenses, it certainly will not have a pressing need to deploy operations utilizing BellSouth's licenses and leases in that band to foster the emergence of such competition.

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[29] Id. at iii.

[30] Id. at iii.

> "For the foregoing reasons, Clearwire urges the Commission to deny the Merger Application. In the alternative, the Commission should condition any grant of the merger Application on the pre-consummation divestiture of the BellSouth licenses and leasehold interests in the 2.5 GHz band to a party with a demonstrated willingness and capability to provide competitive wireless broadband service in that vitally important band."[31]

Clearwire further supports these claims by delineating the incentives that AT&T has to avoid cannibalization of its own services from new technologies deployed using the 2.5 GHz band and slow down new competitors operations, such as Clearwire's. As Clearwire explains:

> "To the extent that WiMax deployments in 2.3 GHz or 2.5 GHz or even other bands have significant advantages, it is particularly important that AT&T not be afforded additional opportunities to delay or impede wireless broadband competitors. Moreover, because Clearwire has every incentive to rapidly and broadly deploy WiMax, and has no alternative broadband offerings to protect unlike other major spectrum holders in that band, *AT&T has a heightened interest in slowing Clearwire by using BellSouth's 2.5 GHz spectrum to restrict access to key markets necessary for Clearwire to fully achieve a national footprint.* Such impediments might relieve any pressure on AT&T to deploy WiMax at 2.3 GHZ, which it might welcome so it could delay cannibalizing its other, perhaps more lucrative, broadband offerings. […] what AT&T is saying is that it does not intend to compete with its own services provided through Cingular. This is precisely the problem. Insofar as Cingular already provides wireless broadband services on a significant and increasing basis, *AT&T has every incentive to "bury" its 2.3 GHz and 2.5 GHz spectrum* in non-core ancillary applications so as to avoid having it be used by a wireless broadband competitor such as Clearwire."[32]

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[31] See Reply Comments of Clearwire Corporation, In the Matter of BellSouth Corporation and AT&T Inc. Application for Consent to Transfer of Control. WC Docket No. 06-74 at 10.

[32] Id. at 14-15.

In the same docket, concurring with Clearwire, The Center for Digital Democracy ("CDD") states:

> "Both AT&T and BellSouth have held (or more accurately, warehoused) spectrum in the 2.3 GHz band. Much more significantly, it is CDD's understanding that BellSouth is the second largest licensee in the 2.5 GHz band, and that it holds 2.5 GHz authorizations in almost all of the top 50 markets. These vast swaths of spectrum are especially well suited for broadband delivery via WiMax or other similar newly evolving technologies. (citation omitted). Allowing the AT&T/BellSouth combination will withhold this potentially competitive wireless option from the market. Once they merge, a fiber-based AT&T would have no incentive to deploy, much less innovate in, wireless broadband services."[33]

Similarly, in the Petition to Deny filed by Consumer Federation of America, Consumers Union, Free Press and U.S. Public Interest Research Group argues that

> "BellSouth holds substantial, in-region licenses and usage rights in the 2.3 to 2.69 GHz band [which] must be considered among the spectrum bands on which mobile broadband services can be offered . . . . [C]hanges in technology and regulation mandate that these ranges of spectrum be considered along with cellular, personal communications service ("PCS"), specialized mobile radio ("SMR") as broadband wireless spectrum. . . . In all of these bands, the next generation of offerings will emphasize broadband anywhere, and mobility will be possible in the 2.5 GHz band within the foreseeable future. The control of this spectrum by a post-merger AT&T would diminish the possibility for competition both for competition in the wireless and broadband markets." (citation omitted).[34]

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[33] Petition to Deny filed by The Center for Digital Democracy, WT Docket No. 03-66 (June 5, 2006), at 6. In its Petition at 6 (citing Mark Del Bianco, Bumps in the road for AT&T-BellSouth merger?, available at: http://news.com.com/Bumps+in+the+road+for=AT38TBellSouth+merger/2010-1037_3-6057214.html).

[34] Petition To Deny filed By Consumer Federation Of America, Consumers Union, Free Press and U.S. Public Interest Research Group (hereinafter "Consumer Groups"), WT Docket No. 0366 (June 5, 2006), Joint Declaration of Mark N. Cooper and Trevor Roycroft at 24-25.

It appears, therefore, that various players in the market were warning the FCC that the unconditional merger of AT&T and BellSouth would provide ample incentives for the merged company to use (or under-use) spectrum at the 2.5 GHz band strategically by warehousing it or otherwise in order to limit competition in wireless services and avoid cannibalizing its existing network assets.

Prior to a conclusion on this point by the FCC, AT&T and BellSouth voluntarily agreed to divest the spectrum BellSouth held at the 2.5 GHz band.[35] Additionally, AT&T and Bellsouth also committed to provide significantly discounted broadband services in the Bellsouth region and to also abstain from requiring consumers to take forced basic and long distance services bundled with the DSL broadband services. In a final gesture of regulatory goodwill, AT&T and Bellsouth also agreed to specific build-out of the 2.3 GHz spectrum in the Bellsouth region. Taken individually and as a whole, these voluntary conditions regarding broadband services give weight to the arguments made by parties that AT&T/Bellsouth having warehoused and potentially continuing to warehouse spectrum as a way of limiting competition in the market for broadband services hold weight.

3. Warehousing in the MVDDS Band

EchoStar Communications Corporation owns 49.9 percent of South.com, a company holding a spectrum license in the 12.2-12.7 GHz, Multichannel Video Distribution and Data Service ("MVDDS") band. The MVDDS band can theoretically be

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[35] See Review of AT&T Inc. and BellSouth Corp. Application for Consent to Transfer of Control, Ex Parte Notice from Robert Quinn, Jr. to Marlene H. Dortch, WC Docket No. 06-74 (filed Dec. 28, 2006).

used for the delivery of new video and broadband communications services, such as local television programming and two-way high-speed Internet access.[36] After a long and tortuous rulemaking and a contentious auction, MVDDS licenses were auctioned in Auctions 53 (in January of 2004) and 63 (in December 2005).[37] South.com was the winning bidder of 37 licenses in Auction 53 out of a total of 192 auctioned licenses. Total gross bids for the auction amounted to $136,936,200.[38]

New unaffiliated entrants such as Northpoint Technology, Ltd. ("Northpoint") and MDS America had sought to provide a competing service to multichannel video services such as those provided by EchoStar using this band. Some three years after the auction, there is no evidence in the record to indicate that South.com or any other auction winner has made any effort to build network facilities that would allow the spectrum to be used for its intended purposes of providing competition in the local video and broadband markets.

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[36] See, "FCC AFFIRMS MVDDS AUTHORIZATION AND ADOPTS SERVICE RULES FOR THE 12.2-12.7 GHZ BAND", FCC News Release, April 23, 2002.

[37] See, STATEMENT OF COMMISSIONER MICHAEL J. COPPS Approving in Part and Dissenting in Part RE: Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range (ET Docket No. 98-206; RM-9147 and RM-9245); Amendment of the Commission's Rules to Authorize Subsidiary Terrestrial Use of the 12.2-12.7 GHz Band by Direct Broadcast Satellite Licensees and Their Affiliates; and Applications of Broadwave USA, PDC Broadband Corporation, and Satellite Receivers, Ltd. to Provide A Fixed Service in the 12.2-12.7 GHz Band. Commissioner Copps expressed his concerns regarding the potential for harm from an "open auction" stating: "I regret that I must dissent, however, to two portions of today's order. I am of firm belief that the open eligibility established by this Order will not maximize the potential benefits of MVDDS or minimize the potential pitfalls of an unconditioned auction. Therefore I must dissent to the eligibility and auction portions of the order."

[38] See Auction 53 Multichannel Video Distribution & Data Service (MVDDS) FCC webpage, available at : http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=53 (website visited on March 16th, 2007).

4. The LMDS Band Case

In March 1998, the FCC auctioned 2 blocks, adding up a total of 1300 MHz of spectrum for private commercial use, in the 28, 29 and 31 GHz frequencies. The bands were reserved to provide broadband Local Multipoint Distribution System services ("LMDS"), a wireless technology for the provision of two-way fixed location broadband services that would directly compete with DSL, cable-modem and other fixed broadband access technologies provided by incumbent telecommunications carriers and cable operators, among others. Initially ILECs were excluded from bidding on the A license but allowed to bid on the B license in their home territory. In one instance, incumbent local exchange carrier USWest acquired licenses in Auction 17 but to date there is little evidence that this spectrum has been used by the carrier for its intended purpose.

5. No Clear Strategy For The AWS Band

Finally, I point to several statements by incumbent carriers who obtained a licenses in the 2006 AWS auction, that indicate that, for some carriers, there is at present no clear strategy to deploy a network using that band. In particular, it appears that after the conclusion of the auction, only T-Mobile announced plans "to build a WCDMA + HSDPA network using the AWS band."[39] By contrast, Cingular and Verizon had not announced plans at the conclusion of the auction. Analyst suggest that

> "Verizon will almost certainly deploy CDMA technology in AWS... eventually. Verizon may choose to wait a while before deploying anything in AWS. They claim to have ample existing spectrum already, and they're one of the few companies rich enough to afford to spend $2.8 billion on spectrum and sit on it for a few years until they need it at a later date."[40]

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[39] "A Visual Guide to AWS", by Rich Brome, Phone Scoop, October 16, 2006, available at: http://www.phonescoop.com/articles/aws/index.php?p=p (website visited on March 26th 2007).

[40] Id.

Similarly, Comcast has yet to announced plans to build-out. Analysts in the sector conclude that they acquired spectrum in the AWS band based on a speculative "wait and see" strategy.

> "SpectrumCo, LLC, a joint venture including Comcast Corporation, Time Warner Cable, Cox Communications, Advance/Newhouse (cable MSOs) and Sprint Nextel Communications, was the winning bidder for 137 wireless spectrum licenses for $2.37 billion in the Federal Communications Commission's advanced wireless services auction, which concluded on September 18, 2006. Comcast Corporation's portion of the total costs to purchase the licenses is $1.29 billion. Time Warner Cable's portion of the costs is $632.2 million and Cox Communications' portion is $248.3 million.
>
> "The licenses provide many options and significant flexibility as the SpectrumCo partners evolve their plans for wireless. The members of SpectrumCo did not approach this investment with the intent of becoming the nation's fifth wireless voice provider, but to obtain greater flexibility in developing options for more advanced wireless services. *While no plans have as yet been finalized, including no specific plans to build out the networks at this time, in coming months the members of SpectrumCo will fully evaluate all options including possible testing in limited markets.*
>
> "There is a finite amount of available spectrum and it is rare that this amount of national spectrum becomes available at auction. The consortium team acquired licenses at attractive prices. The spectrum licenses were won for an average price of $0.45 per megahertz - pop, which was the lowest average price paid by all the major bidders in the auction." (emphasis added)[41]

Analysis from Juniper Research point out the following:

> "Comcast CEO Brian Roberts held fast to his wait and see attitude towards the value of mobile to the cable MSO during an interview at Bear Stearns Media Conference in Palm Beach 3/1. "We don't see the need to make a wireless acquisition to be competitive," said Roberts. *In case the world goes in a direction*

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[41] "Cable Consortium Acquires Spectrum Licenses Covering National Footprint" Comcast Corporation Press Release, Oct. 5, 2006., available at: http://www.cmcsk.com/phoenix.zhtml?c=118591&p=irol-newsArticle&ID=912578&highlight= (website visited on March 26th, 2007).

> *"that we don't see today" he added, the company has its dry powder of 20 MHz of spectrum from the AWS auction.* And Roberts figures those licenses are probably appreciating and making money for Comcast while management watches the business intersections evolve. Meanwhile, Comcast is content to continue its experimentation in the space using Sprint's network. […] Meanwhile, Comcast is charging into landline telephony and aiming to sell 2.6 mil. subscriptions for that service in 2007. It figures having a mobile add-on might net it a fractional gain in that sales goal, but it is fully occupied with its current mandate to sell video, broadband and telephony packages, where the current appetite is enormous. *Take-away: no hurry.*" (emphasis added).[42]

IV. THE CURRENT FCC MODEL FOR ALLOCATING NEW AVAILABLE SPECTRUM IS MARRED WITH DELAYS AND STIFLES NEW VENTURES IN WIRELESS

It has long been argued by students of spectrum policy that the current FCC model for allocating new spectrum is a long, expensive and arduous process that harms new potential competitors' prospects of gaining entry into the market. As a consequence, consumers and the public interest are harmed through this stifling of competition. Of course, not all are harmed by such bureaucratic reality. Incumbent players in the telecommunications sector (whether providing wireless services or fixed services using wire line technologies) are the winners of this institutional maze.

Thomas Hazlett, a longstanding expert in spectrum management policy, has summarized the problem in clear terms.

> "The essence of the problem is this. Under the '27 Radio Act, entrepreneurs have no right to offer consumers additional choices or lower prices. Before they can risk their capital, they must surmount a lengthy and arduous lobbying process, assuming a burden of proof in establishing that their rivalry will enhance the "public interest." That is exactly the sort of dogfight that incumbent

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[42] "Wireless Still a Sideshow at Comcast" Sharon Armbrust, Juniper Research. March 8, 2007., availble at

http://weblogs.jupiterresearch.com/analysts/armbrust/ (website visited on March 26, 2007).

> licensees relish. They can file position papers, raise objections, question assertions of entrants, demand additional information, and present doomsday scenarios about the effect of additional competition. All the while, they win the game through mere delay. After all, they're already in the market, and the new competitors are not. "Heads we win, tails let's flip again. I think that coin is lopsided. When was it calibrated? Who authorized this coin toss? Let's go 447 out of 893. Comments due by July 1, reply comments October 15.
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> "Lawyers and lobbyists get paid generously to generate these delays. Nevertheless, the process is wrong. The consumers' interest is sacrificed. Public-interest outcomes—which are supposed to make the regulated market superior to an unregulated one—are either forgotten or are dwarfed by massive processing costs."[43]

Although Professor Hazlett's comments were with respect to the comparative hearing process, today the same comments could be applied to the development of a band plan and auction design, as he has pointed out in a recent paper.[44] The many other experts in the field of spectrum management have denounced this long and expensive process as a serious barrier to improving the efficient use of scarce spectrum resources. In a 2001 policy recommendation to the FCC, 37 expert economists advocated the need to streamline the ability of new users to obtain transmission rights. According to these scholars, in order "[t]o facilitate this transition to market allocation, the Commission should focus on improving the definition of interference for existing licensees, and *streamlining the ability of new users to obtain transmission rights* where they do not interfere with existing rights. If there are mutually exclusive requests for specific new transmission rights, the Commission should expeditiously conduct an auction. *Strict time*

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[43] See, "Washington's Wireless Wars", by Thomas Hazlett, Manhattan Institute Forum, Autumn 2002, at 2. Available at http://mason.gmu.edu/~thazlett/presentations.html, (website visited on March 9, 2007).

[44] "Spectrum Allocation in Latin America: An Economic Analysis", by Thomas Hazlett and Roberto Muñoz, Sept. 2006, available at : http://papers.ssrn.com/sol3/papers.cfm?abstract_id=928521 (website visited March 25, 2007).

limits should streamline the process whereby an entrant requests permission to use unoccupied frequencies, others are given opportunity similarly to request the desired rights, and competitive bidding procedures are used to resolve the conflict" (emphasis added).[45]

More recently, nine experts in spectrum management policy brought together by the Progress and Freedom Foundation recognized the need for agility in the market as well as the incentives of incumbent players to slow or derail the process of allocating spectrum to new entrants and usages. In order to eliminate or limit this institutional problem, they recommend a mechanism for allocating unassigned spectrum via an "application-driven process, with a *tight timetable* for the *FCC* to respond" (emphasis added).[46] They further explain that the main objective of such streamlining would be to avoid opportunistic, anti-competitive behavior by incumbent carriers. In their words, "[t]he idea here would be to define a timetable that gives the FCC extremely limited discretion in order to limit the ability of incumbents to slow the introduction of new users."[47] Though not in the context of spectrum auctions, Congress has often decreed such limited timetables be imposed on the FCC action regarding competitive entry into various telecommunications markets. As an example, the Telecommunications Act of

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[45] See, "Comments of 37 Concerned Economists" in the Matter of Promoting Efficient use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets, WT Docket No. 00-230, February 7th, 2001. Page 6, available at:

http://www.aei-brookings.org/admin/authorpdfs/page.php?id=417., (website visited on March 10th, 2007).

[46] See, "Digital Age Communications Act: Report from the Working Group on New Spectrum Policy. Release 1.0" The Progress and Freedom Foundation, March 2006, page 12., available at http://www.pff.org/daca/, (website visited on March 13th 2007).

[47] "Digital Age Communications Act: Report from the Working Group on New Spectrum Policy. Release 1.0" The Progress and Freedom Foundation, March 2006, page 12., available at http://www.pff.org/daca/, (website visited on March 13th 2007).

1996, in Section 271, directs the FCC to act upon a Bell Operating Company ("BOC") application to enter into long distance markets within 90 days.[48]

There are multiple examples of long delays in the process of allocating spectrum for private use. Perhaps the most startling examples are the delays in bringing to market the first Advanced Wireless Service ("AWS-1") band; a feat that was finally accomplished in 2006, and the ongoing, seemingly unending process to reallocate the very valuable spectrum in the 700 MHz band. I discuss these in turn below.

A. THE LONG ROAD TO BRINGING ADVANCED WIRELESS SERVICES ("AWS") SPECTRUM TO MARKET

In December of 2000, the FCC adopted a *Notice of Proposed Rulemaking (NPRM) and Order* that formally opened the process to explore the possible use of frequency bands below 3 GHz to support the introduction of new advanced wireless services.[49] These proceedings explored the possibility of introducing new advanced mobile and fixed services in frequency bands that at the time were used for cellular, broadband Personal Communications Service ("PCS"), and Specialized Mobile Radio ("SMR") services, as well as in five other frequency bands: 1710-1755 MHz, 1755-1850 MHz, 2110-2150 MHz, 2160-2165 MHz and 2500-2690 MHz. The NPRM proposed the relocation for mobile and fixed services of the 1710-1755 MHz band, a band that had been designated for relocation from Federal Government to non-Federal Government use under two statutory directives, the 1993 Omnibus Budget Reconciliation Act ("OBRA-

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[48] See Telecom Act 96 § 271(d)(3).

[49] Notice of Proposed Rulemaking and Order (FCC 00-455), December 30th 2000.

93") and the 1997 Balanced Budget Act ("BBA-97"). Similarly, the NPRM proposed to designate advanced mobile and fixed service use of the 2110-2150 MHz and 2160-2165 MHz bands that were at the time used for a variety of fixed and mobile services and that were identified for reallocation under the Commission's 1992 Emerging Technologies proceeding (ET Docket No. 92-9).[50]

In November 2003, almost three years after the adoption of the NPRM, and ten and eleven years, respectively, after the statutory directives to relocate the 1710 and 2110 bands from Federal to private use, the Commission created service rules for 90 megahertz of AWS spectrum at 1710-1755 and 2110-2155 MHz. It took the FCC another two years and ten months to finally auction out these bands.

The first auction of AWS (Auction No. 66) spectrum licenses ended on September 18, 2006. 104 winning bidders won 1087 licenses and the FCC held 35. The total gross revenues from the auction amounted to $13,879,110,200.[51]

It would be comforting to know that, after a formal process of over sixteen years and a proceeding for rulemaking of over five and half years, the allocation of the spectrum would have been accomplished under the most efficient mechanism and in order to maximize social welfare accruing from the use of these public assets. Unfortunately, as I address in the section below, the results of the AWS-1 auction present evidence that the auction was not efficient in allocating these resources. Beyond the unquestionably high loss to consumers from the delays in getting these public assets to

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[50] See, "FCC LOOKS TO ALLOCATE ADDITIONAL SPECTRUM FOR NEW ADVANCED WIRELESS SYSTEMS," FCC News Release, January 4, 2001.

[51] See Auction 66, Advanced Wireless Services (AWS-1) FCC website, available at http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=66 (website visited on March 15th 2007).

market, inefficient auction results may result in costly inefficiencies where spectrum failed to be assigned to the best private uses. The sad result of assignment inefficiencies is that the losses they generate will be singularly borne by consumers.

B. THE 700 MHZ BAND, AN ONGOING SAGA

The spectrum under scrutiny here is the 698-806 MHz band, divided into two sections: the "Lower 700 MHz" band, which goes from 698-746 MHz, and the "Upper 700 MHz" band, spanning the remainder. Historically this band was used for analog television broadcast services, using a technology that was developed at a time when there were few competing uses for spectrum and, hence, the FCC was unconcerned with issues of spectrum efficiency.

In August of 1998 the FCC adopted a First Report and Order and NPRM for "the Development of Operational, Technical and Spectrum Requirements for Meeting Federal, State and Local Public Safety Agency Communication Requirements Through the Year 2010."[52] Following the direction set by Congress, the spectrum was to be reallocated from television broadcast services to public safety communications services as well as made available in part for the provision of private commercial wireless services. TV broadcasting services were to be relocated to other bands using existing spectrum efficient digital broadcasting technology that can achieve higher quality broadcasting results than the current analog systems.

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[52] "First Report and Order and Third Notice of Proposed Rulemaking," FCC Docket No. 96-86. Adopted August 6, 1998.

This process has been characterized by long delays, allegedly for the purpose of commenting and examining technical and operational standards related to the band.[53] To date, this band remains under-used and incumbent broadcasters have yet to vacate the band.

Notwithstanding these procedural complications, following directions from Congress, the FCC did made available portions of the spectrum through two auctions conducted in 2002 and 2003, transferring a total of 36 MHz to private commercial wireless uses.[54] Private enterprises obtaining these licenses would be able to make use of them for the provision of commercial wireless services once the incumbent broadcasting firms vacated the bands. The original target date for existing TV stations to vacate the spectrum was December 31, 2006.[55] At present that date has been postponed to February

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[53] In January 2001, the FCC adopted technical and operational standards for use of the narrow band portion of the band spectrum. The Public Safety National Coordination Committee (NCC), a federal advisory committee, provided recommendations to the Commission on operational and technical parameters for use of the 700 MHz public safety band. The NCC completed the tasks assigned to it in its Charter, the term of which expired on July 25, 2003. The NCC final report and recommendation for adoption of a 700 MHz wideband data standard and other recommendations was filed with the Commission on July 25, 2003.

[54] On September 18th 2002, Auction No. 44 concluded. The FCC auctioned 12 MHz of paired spectrum in the 710-716, 740-746 MHz bands and one unpaired 6 MHz block in the 716-722 MHz band. 484 licenses were granted to 102 bidders and the FCC held 256 licenses. Total gross bids amounted to $116,118,800, while net bids amounted to $88,651,630.

See, "Auction 44: Lower 700 MHz Band" FCC website available at: http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=44 (website visited on March 15th 2007).

On June 13, 2003, Auction No. 49 was completed. In total 35 winning bidders won a total of 251 licenses (5 licenses remained unassigned) were auctioned in the Lower 700 MHz band C and D blocks, or the 710-716/740-746 MHz and 716-722 MHz bands. The auction raised a net total of $56,815,960.

See, "Auction 49 Lower 700 MHz Band" FCC website, available at: http://wireless.fcc.gov/auctions/default.htm?job=releases_auction&id=49&page=P (website visited on March 15th 2007).

[55] See, "700 MHz Public Safety Spectrum" FCC webpage (visited on March 15th 2007).

17, 2009[56] and the licensees remain unable to make use of their acquired licenses and consumers remain unable to reap the benefits stemming from this social asset.

As the long process stands today, an auction to place to market 60 MHz of this valuable band will take place no later than January 28, 2008 as directed by the Digital Television Transition (DTV) and Public Safety Act signed into law by President Bush on February 8, 2006.[57] Still, following mutually exclusive applications for the use of the band, questions remain as to what exactly will be auctioned on that date by the FCC.[58] Throughout this whole process consumers remain unable to reap the benefits from what is by many account a highly valuable public asset.

According to CITA, "[c]onsumers will be Offered a Vast Array of Cutting-Edge Wireless Communications Products and Services because the 700 MHZ Spectrum has Such Favorable Propagation Characteristics. The spectrum made available in the 700 MHz auction will provide consumers with incomparable communication capabilities, freedom, and convenience. This rich spectrum will facilitate mobile wireless broadband services that will dramatically change the way Americans work, live, and play. Even after the successful auction in September 2006 of 90 MHz of Advanced Wireless Services

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[56] "Digital Television Transition and Public Safety Act" February 8, 2006.

[57] "Digital Television Transition and Public Safety Act" February 8, 2006.

[58] Cyren Call proposed to the FCC alternative uses for certain parts of the band where they propose the creation of a nationwide, next-generation wireless broadband network for better public safety communications in a public-private partnership. For more information see Cyren Call's proposal at

http://www.cyrencall.com/ (website visited on Mar. 15, 2007).

spectrum, anticipated growth in consumer usage of bandwidth-intensive services ensures that demand for spectrum in the 700 MHz band will be tremendous."[59]

Other experts agree with CITA. "While it doesn't add that much additional capacity, the range is much better — at least 3 times greater than cellular — and it penetrates inside buildings much better. Some consumer advocates say it is the best shot the FCC has to provide broadband to every American."[60] According to Jim Barthold of Telecommagazine.com "[c]onvergence of available technology and wireless bandwidth could cause a tectonic shift in telecom."[61]

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[59] Statement by CTIA, The Wireless Association, see,

http://www.ctia.org/advocacy/policy_topics/topic.cfm/TID/2 (website visited on March 15th, 2007).

[60] "700 MHZ Spectrum Grab? " Dailywireless.org. October 30th, 2006., available at: http://www.dailywireless.org/2006/10/30/700-mhz-spectrum-grab/ (website visited on March 15th, 2007).

[61] "Mobile WiMAX + 700-MHz Spectrum + Cable: Perfect Together", by Jim Barthold, June 1. 2006 available at http://www.telecommagazine.com/Americas/article.asp?HH_ID=AR_2096 (website visited on March 15th, 2007).

V. A COMPETITIVE BIDDING MECHANISM WHERE INCUMBENT PLAYERS COMPETE UNFETTERED WITH PROSPECTIVE ENTRANTS WOULD NOT BE THE MOST EFFICIENT MEANS TO ASSIGN SPECTRUM

The FCC's decision to use auctions spurred a tremendous amount of academic research. Frankly, the state of economic knowledge about auction design in 1994 was minimal compared to what we know today. In particular, the questions of efficiency in multi-good auctions, multi-dimensional types and auctions with externalities were issues that were nascent in 1994. In this section I briefly outline the rationale for the FCC Simultaneous Multiple-Round ("SMR") auction process and how current thinking affects auction design. I then evaluate three FCC auctions and examine how design has driven auction outcomes. Finally, I examine the repercussions of an auction process in the context of M2Z's business proposal.

A. WHAT CAN AUCTION THEORY TELL US ABOUT THE FCC SMR AUCTIONS?

1. Multidimensional Bidders

The simplest auction model is that where there is a single good "Independent Private Values" model. That is, where each bidder has private valuation that is independent of the other bidders' valuations. In this case an ascending bid auction can be shown to be efficient and raise as much revenue in expectation as other efficient auctions, and there are many efficient types of auction. If we drop the assumption that valuations are independent of other bidders' information, then even auctions with the same

efficiency properties can yield different expected revenue. The guiding principle to choosing a mechanism was discovered in Milgrom and Weber (1981)[62] and has been called the "Linkage Principle" by Paul Milgrom. It is an astoundingly deep and powerful insight that states that "auction formats that reveal more information to the bidders, raise more revenue." This guiding principle drove the FCC to adopt the SMR auction format, a bold decision at the time. The SMR format has been very successful but several problems with FCC auctions drove the academic literature forward.

In particular, when there are multiple licenses to sell and multidimensional bidder types, the linkage principle has been shown to be false in general.[63] Thus even if the SMR auction remains efficient (that is, assigns spectrum to the bidders who value it most), it may not be raising the most expected revenue, even worse, it may be raising less revenue and causing an inefficiency outcome.

2. Combinatorial Values

A second issue arises when bidders valuation present "combinatorial values." That is, where the value of a packaged good to a bidder exceeds the sum of its parts. This problem is endemic in spectrum auctions where bands are sliced and diced into distinct geographical licenses. Combinatorial problems mean that bidders who have winning bids on the components of the package that they desire suffer an "exposure problem." That is, if the value of a license A to a bidder is contingent on obtaining simultaneously license B,

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[62] Milgrom P. & R. Weber. (1982) "The Theory of Auctions and Competitive Bidding", Econometrica Vol 50 at 1089-1122.

[63] Perry M. and P. Reny, (1999) "On the failure of the linkage principle in multi-unit auctions," Econometrica Vol.67 at 895-900.

then a winning bid on license A exposes the bidder to losing the amount of the bid on A whenever A is won but not license B. Bidders faced with such strategic dilemma will either overbid when they are exposed or underbid and drop out of the race early in the bidding process out of fear of exposure. The exposure problem, endemic in telecommunications sector, thus can undermine both the revenue maximization and the allocation efficiency goals of spectrum management. Moreover, it actively discriminates against bidders who want to launch a national service, as they may have to simultaneously win many licenses in order to obtain valuable licenses suitable for their business plans. As an example, in the latest 2006 AWS auction bidders would have had to win almost 1000 distinct geographic licenses in order to gain one national block!

As such, standard FCC spectrum auctions, such as the recent AWS auction, strongly favor local geographic incumbent bidders and disfavor bidders with a national footprint business plan and actively discourage out-of-region competition. This likely means that new entrants, who will need such strategies in order to effectively compete with incumbent wireless providers, are disadvantaged by the auction design.

One solution to this problem that has been proposed as far back as 1994 is to use a combinatorial auction.[64] In the last few years combinatorial auctions have been used to assign everything from used cars to trucking routes to aquaculture licenses. However, the design of combinatorial auctions can be quite complex. This leads to the political economy problem that local incumbent bidders, who can exploit the exposure problem,

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[64] See Chakravorti et. al. (1996). "Auctioning the Airwaves: The Contest for Radio Spectrum," J. of Econ. and Management Strategy, Vol. 4, pp. 344-373, and Ledyard J. “A Brief History of Combined Value Auction Mechanisms,” at http://wireless.fcc.gov/auctions/conferences/combin2000/releases/jledyard.pdf

lobby the FCC against adopting such a mechanism, as happened in the AWS auction. Moreover local incumbents have the incentive to lobby as hard as possible to "slice and dice" the spectrum into licenses that favor their geographic footprint. To date, the FCC has never been able to overcome this political pressure and still uses a knowingly inefficient mechanism. The social costs of this failure can be huge, as shown below.

Although PCS auctions are touted to be a huge victory and the large number of small winners was touted as promoting diversity, the reality is that there were some undesirable consequences from these auctions. First, the sliced up geographical licenses led to a lengthy and costly process of consolidation that eventually seems to have stabilized at a market structure of four major players. This costly and lengthy process was *a priori* unnecessary and directly resulted from the auction design. Second, until such consolidation process was reached, local wireless providers were provided an arbitrage opportunity and there is anecdotal evidence that they charged exorbitant roaming fees to subscribers on larger networks as they passed through their territory.

The inefficient geographical slicing of blocks of spectrum has another unintended consequence. That is the acquisition of licenses not for the purpose of putting them to use and providing new or better services to the general public, but rather for speculative reasons. Such practices have taken place in the past and ultimately forced the FCC to change its rules regarding Designated Entities ("DEs") in 2006.[65] Specifically, the FCC changed its rules related to unjust enrichment payments by determining that, if the DE

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[65] See ORDER ON RECONSIDERATION OF THE SECOND REPORT AND ORDER In the Matter of Implementation of the Commercial Spectrum Enhancement Act and Modernization of the Commission's Competitive Bidding Rules and Procedures, WT Docket No. 05-211. June 1, 2006.

were to sell its licenses within 10 years of obtaining them, it would have to repay all or part of the bidding credit afforded to it at the time of the auction. According to the FCC,

> "The Commission has not been charged with providing entities with a path to financial success, but rather with an obligation to facilitate opportunities for small businesses to provide spectrum based services to the public. Therefore, it is our responsibility to create strong incentives for designated entities to use spectrum to provide facilities-based services to the public instead of holding their licenses and selling them for profit. We believe that our new rules create appropriate incentives in this regard while still affording designated entities the opportunity to achieve financial success by providing service to the public. It is important to remember that designated entities are provided with bidding credits in order to enable them to obtain spectrum and then provide facilities-based service to the public. To the extent that they do not do so, but instead sell their licenses to others in the marketplace at market prices, we believe that it is reasonable that they no longer be allowed to enjoy the benefit of obtaining spectrum at below-market prices."[66]

3. Externalities

A third issue regarding FCC auction design is the role of externalities. As I mentioned above, the most prominent type of externality is when an incumbent carrier would be prepared to outbid an entrant. When valuation externalities exist, the value of the license to all the bidders, including the losing participants, depends on the identity of the winner. Under such inter-dependent private valuations, auction properties will differ from the standard model. There recently have been some advances in the economic literature on modeling auctions with this property. Unfortunately, the results indicate that efficiency and revenue maximization properties attained under more simplistic valuation assumptions no longer hold.

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[66] Id. at 17.

One auction design that has been found to be efficient is the "Combinatorial Vickery Mechanism" ("CVM"). This mechanism, although auction-like, requires bidders to report a vector of contingent valuations rather than simple prices. Indeed, when such a paper was presented at a conference and it was suggested that it couldn't be used in the real world, Bob Wilson, one of the designers of the FCC SMR auction, suggested that this mechanism looked like the FCC comparative hearings process![67]

However, things get worse. In circumstances when the CVM fails to achieve efficient outcomes, Dasgupta and Maskin (2000) Jehiel and Moldavanu (2001) show that there is no efficient incentive-compatible auction mechanism. In other words, economic theory today tells us that, when there exist valuation-externalities such as those commonly present in spectrum auctions, every auction mechanism is either inefficient or dictatorial.

As I describe in detail in Section III, where I discuss incentives for warehousing and discuss various examples of such behavior, and below in Section VI, when I examine various examples of FCC auctions gone awry, externality valuations are very much real in the sector.[68] Thus the naive belief that an auction is always the solution to the social

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[67] See Dasgupta, P. and E. Maskin (2000) "Efficient Auctions," Quarterly J. of Econ Vol. CXV pp. 341-388 and Jehiel, P. and B. Moldanavu (2001) "Efficient Design with Interdependent Valuations," Econometrica, Vol 69. at 1237-1259, and (2005). "Allocative and Informational Externalities in Auctions and Related Meechanisms," Econometric Society World Congress Lecture, London, 2005.

[68] Another example of the incentive for warehousing that incumbent carriers have and is encouraged whenever Blocks of spectrum are sliced geographically was described by Clearwire Corporation (Clearwire) in its arguments opposing the AT&T-BellSouth merger in 2006, unless it was forced to divest its spectrum at the 2.5 GHz band. Clearwire concluded that the "[a]pplicant's argument that AT&T will not have the incentive to use or warehouse the 2.5 GHz spectrum in order to impede nationwide mobile broadband competition from emerging in that band is incorrect". To support this claim Clearwire argued that "[t]he merger would put into the hands of AT&T assets which are vital to everyone who wants to provide a competitive

allocation of resources is a matter of economic theory now known to be in error. In short, a M2Z's proposal cannot be ruled out on *a priori* efficiency or non-discrimination grounds as every auction allocation mechanism will fail these tests.

B. AUCTIONS IN THE CONTEXT OF M2Z'S APPLICATION

M2Z's Application envisions the introduction of a nationwide wireless broadband service based on the WiMax technology standard utilizing the 2155-2175 MHz frequency band. M2Z's service would comprise of (1) a free service comparable to basic DSL service and (2) a paid subscription service with faster (3 Mbps) data transfer rates. Both the free and paid subscription services would require consumers to purchase a certified reception device (estimated to cost $250 initially, with lower costs over time) and register with M2Z. According to their business plan, the free subscription service would be financed via advertising revenues.[69]

This business plan, therefore, incorporates an innovative concept in the market for broadband access services based on advertising (a model used in other sectors including ISP and broadcasting services) that offers a higher share of the social rents of the venture

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nationwide mobile broadband service to consumers in the 2.5 GHz band […]. To impede nationwide mobile wireless broadband platform from being developed in the 2.5 GHz that would compete with AT&T's national and nearly national networks, AT&T need not do much of anything with this spectrum. All it need do is abstain from building mobile wireless broadband capabilities that permit customers to have access to the 2.5 GHz band spectrum in AT&T markets. This would allow AT&T to ensure that there would be gaps in coverage in some geographic areas where it controls the vast majority of channels in that band. "Not only will AT&T have the ability to impede the development of a nationwide 2.5 GHz platform and an incentive to do so, it will have a greater incentive than BellSouth." See Reply of Clearwire Corporation to Joint Opposition of AT&T Inc. and BellSouth Corporation to Petitions to Deny and Reply to Comments" WC Docket no. 06-74.

[69] See, M2Z Proposal.

to consumers who chose to subscribe to the free service but also signifies higher risks for the service provider. This commercial proposal could be attractive for some consumers who may choose to switch from broadband providers, and hence save subscription charges, or upgrade their chosen access modes from dial-up services to M2Z's free broadband service. Furthermore, the low cost of the service (free save for the one-time customer premise equipment cost) may entice other consumers who today are not Internet users to get online. The business model also suggests that as some of the users of the free service learn the benefits of broadband access they will value the service more and, eventually, will be more willing to pay subscription charges for the higher capacity service from M2Z or other competitive providers.

From a public policy perspective, this proposal has appealing attributes. First, through its free service, M2Z would transfer a higher percentage of the social rents to consumers, hence significantly increasing consumer surplus as compared to alternative commercial subscription services that do not lower the cost of use of broadband. Second, by doing so, M2Z's business plan would expand broadband deployment, increase competition in the provision of broadband services, could help ignite consumer interest in broadband services and affect the level of Internet access among certain parts of the population—a stated bipartisan political goal.[70]

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[70] See, President George W. Bush's Technology Agenda, available at: http://www.whitehouse.gov/infocus/technology/ (website visited on March 15th, 2007.

Also see, "Pelosi to Bush: Let's Work Together to Improve America's Global Competitiveness" Letter from House Speaker Nancy Pelosi to President Bush, February 14, 2006, available at http://www.house.gov/pelosi/press/releases/Feb06/GlobalCompetitiveness.html (website visited on March 15th, 2007).

Furthermore, as I pointed out in the report "The Consumer Welfare Impact of M2Z Networks Inc.'s Wireless Broadband Proposal", M2Z's entry has the potential to dramatically alter the pattern of competition in the market for broadband access.[71] According to FCC data as of June 30, 2006, approximately 94 percent of broadband connections in the U.S. were provided by cable and telephone companies.[72] Thus, there appears to be a "cable and telephone broadband duopoly"[73] in the U.S. M2Z's entry will alter the duopoly structure of the market for broadband access and through the provision of its free-of-subscription service has the potential to significantly ignite competition in the sector.

For all of these reasons, M2Z's proposal could have profound effects upon the market and generate significant social value. According to my own very conservative estimates, the consumer benefits from M2Z's entry will likely result in a Net Present Value ("NPV") as of 2007 of benefits to U.S. consumers of broadband and telecommunications services ranging from $18 billion to more than $25 billion.[74] Specifically, I estimate the NPV of benefits to broadband subscribers due to the competitive impact of M2Z's entry, resulting in lower prices for all broadband consumers of more than $13 billion from 2008 onwards. In addition, I estimate the NPV of benefits

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[71] See Simon Wilkie, "The Consumer Welfare Impact of M2Z Networks Inc.'s Wireless Broadband Proposal," WT Docket No. 07-16, at 3, 8 (submitted Mar. 2, 2007) (Wilkie, "Consumer Welfare Impact").

[72] According to the most recent FCC report pertaining to High-Speed Services for Internet Access, out of a total of 64,614,270 high-speed lines, 60,496,807 were provided by RBOCs, other ILECs, and cable modem providers. See, FCC, Wireline Competition Bureau, Industry Analysis and Technology Division, HIGH-SPEED SERVICES FOR INTERNET ACCESS: STATUS AS OF JUNE 30, 2006, January 2007, Table 6.

[73] See, CRS Report for Congress, Order Code RL33496, Access to Broadband Networks, Updated August 31, 2006, at 17.

[74] See Wilkie, "Consumer Welfare Impact."

to consumers of broadband and telecommunications services from increased broadband access made possible by M2Z's free service ranging from more than $5 billion to more than $12 billion over the period 2008 to 2022.[75]

However, the business strategy proposed by M2Z entails high risks and delayed expected earnings, due to the provision of a basic broadband access service for free, and, hence, lower present value that a proposal more in line with current subscription-only business models for the provision of wired and wireless broadband services. In the event that such a business plan would have to compete in a competitive bidding context for the right to enter the market by acquiring the necessary spectrum license, it would be disadvantaged and likely quickly out-bided by competitors. This is particularly so if business plans such as M2Z's, focusing on strategies to attract customers in a market that is already relatively matured, have to compete head to head for the acquisition of spectrum against incumbent players.

This asymmetry between new entrants and incumbent players in the market for telecommunications raises important public policy issues with respect to spectrum policy. As I describe above, the theory points out that in an open auction with multidimensional valuations, the socially optimal outcome would not be achieved unless transfer payments across bidders were included in the auction design. In the absence of such politically unfeasible corrective design mechanisms, the auction would favor by design bidders whose private valuation is highest, while disfavoring and possibly excluding from the

[75] I also estimate a NPV of benefits from royalty payments for the spectrum to be leased by M2Z ranging from more than $35 million to more than $536 million from 2008 onwards (under less conservative assumptions regarding M2Z's paid subscribers, the estimated NPV of these royalty payments ranges from more than $71 million to more than $1 billion).

market those bidders whose private valuation is lower, by transferring a greater portion of the rents of the venture to its consumers.

Such auctions may be consistent with a goal of maximizing revenues from competitive bidding processes, but they are not consistent with the statutory goal of the Commission to maximize the social benefit from the spectrum usage nor, given today's state of the telecommunications market, with promotion of entry and competition.[76]

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[76] Under Section 309(j)(3) A and B, the Telecommunications Act of 1996 states the following goals as guidance for spectrum allocation:

"(A) the development and rapid deployment of new technologies, products, and services for the benefit of the public, including those residing in rural areas, without administrative or judicial delays;

"(B) promoting economic opportunity and competition and ensuring that new and innovative technologies are readily accessible to the American people by avoiding excessive concentration of licenses and by disseminating licenses among a wide variety of applicants, including small businesses, rural telephone companies, and businesses owned by members of minority groups and women."

VI. AUCTIONS VERSUS EX-POST ROYALTY PAYMENTS

A. THERE IS NOTHING INHERENTLY INEFFICIENT IN ROYALTY PAYMENT PROPOSAL

Royalty payments are a commonly used form of contract associated with public or private resources that are leased or sold to third parties. In and of itself, a mechanism of royalty payments for the lease of an asset is not an inefficient contract. Indeed, royalty payments, whereby the owner or manager of an asset agrees to sell or allow the use of the asset to third parties for a fee contingent on revenues or profits in the associated downstream markets, is a common occurrence. We have many examples of such contracts for the lease of public assets, such as mining rights for natural resources on public lands and seas, exploitation of public forests, or private assets, such as the rights to use a patent owned by private firms or by not-for-profit organizations, such as many universities and research institutions. In and of itself, therefore, royalties are neither an anomaly nor an inefficient contract mechanism.

In the context of spectrum licenses, auction mechanisms are relatively new instruments for assigning spectrum and royalties have been applied in the past and remain in use. The FCC acknowledges that auctions are not the only mechanism to assign this resource in its 2006-2011 Strategic Plan, stating that "[t]he Commission shall also

evaluate and refine, where necessary, its spectrum assignment policies and procedures, including but not limited to its auction processes."[77]

From an economic perspective, the use of auctions can be an effective and transparent market-based mechanism to assign scarce resources across competing private applications. However, as I have argued above, in the case of spectrum management, where there are strategic incentives for incumbent carriers to use the rulemaking and auction processes anti-competitively by seeking to curtail or slow entry, auction mechanisms can result in socially suboptimal outcomes and even constitute a *de facto* barrier to entry that mars competition.

Furthermore, auctions for spectrum licenses don't always turn out to be the most efficient mechanism for allocation of scarce resources that the theory predicts. In what follows I contrast results under different spectrum auctions conducted by the FCC and analyze the structural reasons for their success and/or failure.

B. M2Z'S PROPOSAL DOES NOT CONSTITUTE A FREE SPECTRUM ENTITLEMENT

Finally, contrary to what some carriers argue in their Petitions to Deny M2Z's Application to the FCC,[78] granting M2Z's Application would not amount to a windfall

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[77] FCC Strategic Plan 2006-2011, available at: http://www.fcc.gov/omd/strategicplan/ (website visited on March 21 , 2007).

[78] See AT&T Inc., Petition to Deny, WT Docket No. 07-16 (submitted Mar. 2, 2007) ("AT&T Petition to Deny"); CTIA – The Wireless Association, Petition to Deny, WT Docket No. 07-16 (submitted Mar. 2, 2007) ("CTIA Petition to Deny"); Petition to Deny of Motorola, Inc., WT Docket No. 07-16 (submitted Mar. 2, 2007) ("Motorola Petition to Deny"); NextWave Broadband Inc., Petition to Deny, WT Docket No. 07-16 (submitted Mar. 2, 2007) ("NextWave Petition to Deny"); Petition to Deny of T-Mobile USA, Inc., WT Docket No. 07-16 (submitted Mar. 2, 2007)

profit, a free entitlement or an anti-competitive advantage. According to M2Z's Application, M2Z would pay 5 percent of the gross revenues from its paid subscription service to the U.S. Treasury each year.[79] Given conservative projections of number of paid subscribers after 10 years of operation, I have calculated that royalty payments under M2Z's proposal would amount to a NPV of between $35 million to over $500 million, assuming modest uptake of subscriber customers. Under more optimistic but still realistic subscriber projections, the NPV of royalty payments under M2Z's proposal could be as high as $1 billion.[80] These figures do not constitute a free entitlement.

Moreover, royalties are not equivalent to installment payments, as some commentators have suggested. In particular installment payments induced the problem of creating an option value that ameliorates the winners curse and induces overbidding, thereby causing bankruptcy with a high degree of probability. With installment payments, if the license holders' cash flow becomes insufficient to cover the payments, then a default mechanism is triggered, and the winning bidder is in violation of the license terms. This endangers their ability to get financing and can cause bankruptcy. Once bankruptcy occurs the license holder is unable to deploy its network, which ensues a litigation process between the FCC and license holder.

("T-Mobile Petition to Deny"); Petition to Deny of Verizon Wireless, WT Docket No. 07-16 (submitted Mar. 2, 2007) ("Verizon Wireless Petition to Deny"); Wireless Communications Association International, Inc., Petition to Deny, WT Docket No. 07-16 (submitted Mar. 2, 2007) ("WCA Petition to Deny"); Comments of the Consumer Electronics Association, WT Docket No. 07-.16 (submitted Mar. 2, 2007) ("CEA Comments"); Opposition of EchoStar Satellite L.L.C., WT Docket No. 07-16, at 1–2 (submitted Mar. 2, 2007) ("EchoStar Opposition").

[79] See, M2Z Application, at 4.

[80] See, Wilkie "Consumer Welfare Analysis."

By contrast, under an *ex-post* royalty payment mechanism there is no structurally induced "over-bidding" and the license holder can accommodate greater variability in revenues without license payments threatening bankruptcy. Royalty payments are an efficient risk sharing mechanism whereas installment payments shift all the downside risk to the FCC and upside gain to the licensee.

C. FCC AUCTIONS ARE NOT ALWAYS EFFICIENT

1. PCS Blocks A and B, Auction No. 4

Perhaps the most successful auction was Auction 4, the first PCS auction for the A and B Block PCS licenses. One of the canonical tests for market efficiency is the "law of one price" or the no arbitrage profits condition. The logic behind this theorem is compelling. If two goods are essentially the same they should be selling for the same price, otherwise there is a value gap, whereby we could reallocate the good from the lower value user to the higher value or paying user and increase total social value. In the context of the FCC SMR auction, the price should be set by the marginal bidder, that is the third highest valuation in the auction. However, because of the eligibility rules and size of the bid increment, the implication of efficiency is that the A and B block prices for each individual market should not differ by more than two bid increments, or by 10%. A larger price difference is evidence of some strategic gaming of the mechanism or of the exposure problems discussed above. This test was applied to the Auction 4 by Ausubel et al (1997) to show the efficiency of the SMR auction.[81] I reproduce the data below.

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[81] Ausubel, L. et al. (1997) "Synergies in Wireless Telephony: Evidence from the Broadband PCS Auctions," J.of Economics and Management Strategy, Vol. 6, pp 497-527.

TABLE 1: Broadband PCS A and B Block (Auction 4)					
MTA No.	Market Name	Pop (Millions)	$ / (MHz x Population) /1		
			A Block30MHz	B Block 30MHz	Ratio
1	New York	26.4	PP /2	$0.56	
2	Los Angeles	19.1	PP /2	$0.86	
3	Chicago	12.1	$1.03	$1.06	0.97
4	San Francisco	11.9	$0.58	$0.57	1.02
5	Detroit	10.0	$0.27	$0.29	0.94
6	Charlotte	9.8	$0.23	$0.24	0.94
7	Dallas	9.7	$0.30	$0.30	0.99
8	Boston	9.5	$0.43	$0.45	0.96
9	Philadelphia	8.9	$0.30	$0.32	0.95
10	Washington	7.8	PP /2	$0.91	
11	Atlanta	6.9	$0.95	$0.89	1.07
12	Minneapolis	6.0	$0.22	$0.20	1.08
13	Tampa	5.4	$0.55	$0.61	0.90
14	Houston	5.2	$0.54	$0.53	1.01
15	Miami	5.1	$0.85	$0.82	1.05
16	Cleveland	4.9	$0.59	$0.58	1.01
17	New Orleans	4.9	$0.64	$0.61	1.05
18	Cincinnati	4.7	$0.30	$0.30	0.98
19	St. Louis	4.7	$0.85	$0.82	1.04
20	Milwaukee	4.5	$0.62	$0.63	0.99
21	Pittsburgh	4.1	$0.23	$0.26	0.91
22	Denver	3.9	$0.55	$0.55	1.00
23	Richmond	3.8	$0.29	$0.29	1.02
24	Seattle	3.8	$0.93	$0.92	1.01
25	Puerto Rico	3.6	$0.52	$0.50	1.04
26	Louisville	3.6	$0.46	$0.44	1.06
27	Phoenix	3.5	$0.74	$0.72	1.04
28	Memphis	3.5	$0.42	$0.42	1.00
29	Birmingham	3.2	$0.37	$0.36	1.01
30	Portland	3.1	$0.37	$0.37	1.00
31	Indianapolis	3.0	$0.78	$0.79	0.99
32	Des Moines	3.0	$0.25	$0.23	1.05
33	San Antonio	3.0	$0.61	$0.58	1.05
34	Kansas City	2.9	$0.27	$0.27	1.00
35	Buffalo	2.8	$0.23	$0.24	0.95
36	Salt Lake City	2.6	$0.59	$0.60	0.99
37	Jacksonville	2.3	$0.67	$0.65	1.03
38	Columbus	2.1	$0.35	$0.34	1.01
39	El Paso	2.1	$0.14	$0.14	1.00
40	Little Rock	2.1	$0.21	$0.20	1.03
41	Oklahoma	1.9	$0.20	$0.23	0.85
42	Spokane	1.9	$0.10	$0.11	0.92
43	Nashville	1.8	$0.31	$0.30	1.04
44	Knoxville	1.7	$0.21	$0.22	0.95
45	Omaha	1.7	$0.09	$0.10	0.92
46	Wichita	1.1	$0.13	$0.15	0.90

TABLE 1: Broadband PCS A and B Block (Auction 4), Con't					
MTA No.	Market Name	Pop (Millions)	$ / (MHz x Population) /1		
			A Block30MHz	B Block 30MHz	Ratio
47	Honolulu	1.1	$0.67	$0.65	1.03
48	Tulsa	1.1	$0.53	$0.51	1.05
49	Alaska	.6	$0.06	$0.10	0.61
50	Guam	.2	$0.02	$0.03	0.75
51	Amer. Samoa	.0	$0.15	$0.16	0.94
		Average	**$0.49**	**$0.54**	**0.91**

Source: http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=4 (website visited on March 22, 2007).
Notes:
/1 Reported prices based on gross winning bids.
/2 The A block PCS licenses in New York, Los Angeles, and Washington D.C. were awarded under the FCC's Pioneer's Preference Rule, and are excluded.

It is striking how efficient the SMR auction mechanism was in this case. However, the auction was not a plain auction. In particular, the FCC had in place spectrum caps, which prohibited the incumbent license holders from bidding in areas where they already held licenses. Thus, the FCC in this case was able to encourage entry, get an efficient outcome through the auction mechanism as well as raise significant revenue for the public, achieving the goals set by Congress. The lessons learned from this case are that Auction 4 was a huge success because; (i) spectrum caps stopped incumbents from being able to foreclose entry, (ii) the terms of service were homogeneous (i.e., PCS) so each bidder had a similar business plan, i.e., subscription CMRS service, and (iii) licenses were relatively large.

2. PCS Block C, Auction No. 5

Unfortunately the following auction, the C Block, or Auction 5 is an infamous disaster. In that auction spectrum was set aside for designated entities and bidder financing via installment payments were introduced. Prices from this auction compared

with those from Auction 4 for the A & B Blocks doubled, again, a striking failure of the "law of one price" and a red flag signaling inefficiency. Indeed the winners in Auction 5 soon went bankrupt and the FCC never collected the revenue and subsequently became embroiled in litigation. The resulting loss in consumer welfare stemming from un-used spectrum for such a long time has been estimated at many billions of dollars.[82] Indeed the upcoming auction, number 77 is yet another re-auction of the C Block licenses. This auction will be the sixth time certain parts of Block C have been on the block! This of course undercuts the argument that auction mechanisms will necessarily ensure efficient and rapid allocation of spectrum license in the market.

3. AWS Auction No. 66

The 2006 AWS Auction No. 66, which concluded on September 18th 2006,[83] presents another example of a competitive bidding process where the market outcome was not efficient. Economic theory predicts that efficient markets will clear when prices for equivalent goods or services are sold under similar circumstances converge. Furthermore, goods that are of superior quality will present higher prices than those of inferior public value or quality.

In the context of the AWS auction we find that we can test these hypotheses in two ways. The auction brought to market simultaneously 1,122 licenses, of which 1,087

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[82] "Spectrum Allocation in Latin America: An Economic Analysis", by Thomas Hazlett and Roberto Muñoz, Sept. 2006, available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=928521 /Website visited March 25. 2007).

[83] See AWS Auction 66 Summary Results, available at: http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=66 (website visited on March 21st 2007).

were won by 104 bidders. The block bands allotted measured either 10 MHz or 20 MHz. Furthermore, the licenses were assigned by different geographical regions of three kinds: 734 licenses for cellular market areas (CMA), 176 licenses for economic areas (EA) and 12 for Regional Economic Area Groupings (REAG), which encompass the largest geographical area per license. There were no licenses allotted at the national level. A summary of the license structure is provided in the Table 2 below:

Table 2: Blocks included in AWS Auction No. 66

Block	Band (MHz)	Size (MHz)	Geographical Area	No. of Licenses
A	1710-1720 / 2110-2120	20	Cellular Market Area (CMA)	734
B	1720-1730 / 2120-2130	20	Economic Area (EA)	176
C	1730-1735 / 2130-2135	10	Economic Area (EA)	176
D	1735-1740 / 2135-2140	10	Regional Economic Area Grouping (REAG)	12
E	1740-1745 / 2140-2145	10	Regional Economic Area Grouping (REAG)	12
F	1745-1755 / 2145-2155	20	Regional Economic Area Grouping (REAG)	12

Source: http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=66 (website visited on March 22, 2007).

Taking the auction structure into account, we would expect an efficient auction outcome to present two key characteristics: a) prices of bands of identical size in the same geographical area would be similar, and b) a 20 MHz license should be worth more than a 10 MHz license within the same geographical area in absolute terms as well as relative terms, that is, taking into account price per MHz per population covered by the license.

The following table compares the prices of different blocks in the auction. In particular, Blocks B and C were divided up into smaller geographic areas, EAs, than the D, E and F Block, which were REAGs. However, EA's are a refinement of REAGs, and so if we aggregate all the EAs in a given REAG, one obtains a substitute good of the same size and footprint. Indeed we saw bidders moving across REAG and EAs through the different bidding rounds. The A Block licenses were defined by CMAs, which unfortunately are not nested in EAs, making direct one to one comparison problematic. A summary of pricing data for the different blocks is presented in Table 3 below.

Table 3: AWS Auction (Auction 66). Prices

$ / (MHz x Population) /1

Region	Market Name	Population (Millions)	Block				
			B: 20 MHz	C: 10 MHz	D: 10 MHz	E: 10 MHz	F: 20 MHz
REAG1	Northeast	50.1	$0.65	$0.94	$1.10	$0.94	$1.33
REAG2	Southeast	49.7	$0.43	$0.45	$0.48	$0.63	$0.58
REAG3	Great Lakes	58.2	$0.43	$0.58	$0.63	$0.61	$0.53
REAG4	Mississippi Valley	31.3	$0.28	$0.31	$0.35	$0.34	$0.44
REAG5	Central	40.3	$0.32	$0.33	$0.33	$0.30	$0.58
REAG6	West	50.0	$0.43	$0.44	$0.71	$0.73	$0.89
		Average	**$0.44**	**$0.53**	**$0.63**	**$0.62**	**$0.74**

Source: http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=66 (website visited on March 22, 2007).

Notes: /1 Reported prices based on gross winning bids.

In stark contrast to Auction 4, that the price ratios for Auction 66 vary more than 10%. Indeed taking the maximum price discrepancy for each REAG we have relative price ratios of; 2.05, 1.46, 1.45, 1.57, 1.76, 2.06, with an average of 1.68. Prices varied by as much as 100%, which is inconsistent with efficiency.

By looking at licenses covering geographic areas with a total population of over 5 million, I test these two hypotheses. This sub-sample includes 47 licenses affecting the

largest population areas in 23 distinct geographical areas.[84] Table 4 below presents summary statistics of the results of the auction.

Table 4. Summary Statistics of AWS Auction 66
Licenses covering more the 5 million population

	All Licenses	20 MHz band Licenses	10 MHz band Licenses
Average Price/MHz/pop	$0.680	$0.709	$0.653
Standard Deviation	$0.333	$0.331	$0.340
Max Price/MHz/pop	$1.575	$1.575	$1.569
Min Price/MHz/pop	$0.303	$0.323	$0.303
Max No. Bidding Rounds	53	52	53
Min No. Bidding Rounds	12	14	12
Number of Licenses	47	23	24

Source: http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=66 (website visited on March 22, 2007).

Price per MHz per pop for the 20 MHz licenses is greater, although not by much, than the average price paid per MHz per pop for the smaller bands. This is consistent with the hypothesis stated above. However, when we look at specific markets where more than one license was allotted of differing size, we find a number of instances where results are inconsistent with efficient outcomes.

Forty-three of the licenses allotted cover areas where more than one license is offered of differing size of either 10 or 20 MHz. These licenses are offered in 18 distinct geographical markets. In 10 of these markets the price per MHz per pop is greater for the

[84] 42 of these licenses cover geographical areas where more then one license is offered (either 2 or 3, depending of the type of license). The remaining five are A Block licenses offered in smaller geographical areas. In total the sample includes 23 distinct geographic areas and 18 where at least 2 licenses of different size are offered.

smaller 10 MHz band. In some cases this difference is significant. In the market AW-BEA010 corresponding to parts of New England and New York (NYC-Long Is. NY-NJ-CT-PA-MA-VT), the mark-up for the smaller 10 MHz license was 55.47% over the price per MHz per pop of the larger 20 MHz band ($1.415 per MHz/pop for the 10 MHz band versus $0.910 per MHz/pop for the larger band). Similarly, in market AW-BEA012, in the mid-Atlantic region (Phil.-Atlantic City PA-NJ-DE-MD), the price of the smaller 10 MHz band was 44.12% greater then the price per MHz per pop paid for the larger 20 MHz band ($0.767 per MHz/pop for the 10 MHz band versus $0.532 per MHz/pop for the larger band).

In the market of Puerto Rico and the US Virgin Islands (market AW-REA010) we also observe this phenomenon. All three licenses of 10 MHz had a higher per MHz per pop price than the 20 MHz license. The price per MHz per pop paid for the most expensive 10 MHz band was 52.55% higher than for the larger band ($0.070 per MHz/pop for the 10 MHz band versus $0.046 per MHz/pop for the larger band). A similar outcome resulted in Alaska, license AW-REA007, where the mark-up for the smaller bands was 84.67% ($0.175 per MHz/pop for the 10 MHz band versus $0.095 per MHz/pop for the larger band). Results in the Alaska market imply that the price paid for the smaller license was similar in absolute to the price paid for the 20 MHz license.

The sub-sample of REAG includes 12 distinct geographical markets where three licenses were awarded, one of 20 MHz in size and two of 10 MHz. In this sub-sample I test the spread of the prices paid for Blocks D & E of identical size.[85] The smallest price

[85] Excluding market AW-REA011, corresponding to American Samoa, where no bids were entered and market AW-REA009, corresponding to Guam, Northern Mariana Islands, where there was bidding for only one 10 MHz license.

spread was in the Alaska market where prices for the two identically sized licenses differed by only 0.18%. The largest price spread was in the market of Hawaii where the price spread across the two 10 MHz licenses was 33.91%. The market for the Southeast of the USA resulted in a price spread across the two 10 MHz licenses of 31.47%. Prices across these licenses in the Northeast market differed by 16.96% and in the Central area by 10.36%. In the four remaining markets, the price spread was less than 10%.

The results of this auction for some of these markets present a marked deviation from what we would have expected from an efficient competitive market mechanism. Markups over identically sized blocks of over 30% are inconsistent with an efficient market clearance outcome. Furthermore, markups of 40%, 50%, or, in the case of Alaska, 80% for the price of the smaller 10 MHz band over the larger 20 MHz band are inconsistent with theoretical predictions.

I also look at the pattern of competition in the auction taking into account the number of rounds in each market. A summary of the statistics of the AWS auction classified according to the number of rounds of bidding for each license is presented in Table 5.

Table 5. Summary Statistics of AWS Auction 66, By Number of Rounds of Bidding

Rounds of Bidding	Number of Licenses	Population Covered by License*	Max Population Covered by a Given License	Average Price Per MHz/pop	Max Price Per MHz/pop	Min Price Per MHz/pop
Zero	35	8,668,559	3,917,222	$0.000	$0.000	$0.000
One	34	6,886,684	3,917,222	$0.031	$0.050	$0.029
From 2 - 10	24	2,870,756	371,691	$0.065	$0.146	$0.030
From 11 - 20	36	831,794,213	58,178,304	$0.416	$1.334	$0.030
From 21 - 50	359	530,034,701	40,343,960	$0.199	$1.592	$0.029
From 50 -160	634	333,467,757	10,328,854	$0.187	$1.575	$0.029

Sources: http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=66 and http://wireless.fcc.gov/auctions/default.htm?job=maps (websites visited on March 22, 2007).
Notes: Sum of total population covered by licenses. May include double counts where more than one license per area is included in categories.

The AWS Auction 66 auctioned 1,122 different licenses, some of which, as I explain above, correspond to the same geographical market. The maximum number of rounds of bidding for any license was 161 and on average there were 57.028 rounds of bidding across all licenses. In total, 35 licenses were uncontested (zero bids) and 34 had only one round of bidding, implying that only one bidder was interested in the band and, hence, there was no competitive bidding for those licenses. A further 158 licenses were sold for the minimum opening, which is particularly striking as the FCC lowered the minimum opening bid to $0.03 MHz/pop. In total 482 licenses covering 109 million pops, approximately 38%, of the country sold for $0.10 per MHz/pop or less. These results indicate that given the license design and the usage specifications, many of the licenses had little or no value for private competitors. Of course the unsold spectrum will lie fallow, but it is also likely given these low prices that the winning bidders are not

planning to actively use the spectrum but rather have acquired it following a "wait and see" strategy.

Table 6: AWS Auction (Auction 66)		
	No. of Licenses	**Population of Geographic Area Covered by Licenses (Millions)**
FCC Held Licenses	35	8.0
Licenses that Sold for the Minimum Opening Bid	158	30.4
Licenses that Sold for $0.10 or Less /1	482	109.0

Source: http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=66 (website visited on March 22, 2007).

Notes:

/1 Based on gross winning bids. Six licenses for the Gulf of Mexico do not have any reported population, and hence are excluded. FCC held licenses are also excluded.

The last question I address is whether the auction encouraged efficient entry. Although a large number of entrants won licenses, they were largely in smaller markets. An examination of the top 25 metro markets reveals a different picture.

Table 7: AWS Auction (Auction 66)				
Winners of Top 25 CMAs (by Population) and Corresponding BEAs and REAGs /1				
Winner	**No. of Licenses Covering Top 25 CMAs /1**	**MHz x Population (Millions)**	**MHz x Population (%)**	**Incumbent or Incumbent Ownership Interest**
Atlantic Wireless, L.P.	4	207.6	1.1%	
AWS Wireless Inc.	2	79.9	0.4%	
Barat Wireless, L.P.	2	384.4	2.1%	Yes
Cavalier Wireless, LLC	1	43.5	0.2%	
Cellco Partnership d/b/a Verizon Wireless	4	3784.8	20.7%	Yes
Cingular AWS, LLC	15	1942.4	10.6%	Yes
Cricket Licensee (Reauction), Inc.	9	856.0	4.7%	Yes
Daredevil Communications LLC	1	35.6	0.2%	
Denali Spectrum License, LLC	1	581.8	3.2%	Yes
FCC	1	78.3	0.4%	FCC
MetroPCS AWS, LLC	5	1403.8	7.7%	Yes
SpectrumCo LLC	22	3054.8	16.7%	Yes
T-Mobile License LLC	24	5764.0	31.6%	Yes
Triad AWS, Inc.	1	39.2	0.2%	
MHz x Population (%) of Non-Incumbents			**2.2%**	

Sources: http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=66 and http://wireless.fcc.gov/auctions/default.htm?job=maps (websites visited on March 22, 2007).
Notes: /1 In addition to the top 25 CMAs (by population), the BEAs and REAGs that cover the top 25 CMAs were included in the calculations.

In fact, new entrants only won 2.2% of the MHz/pops in the top 25 markets (or supersets thereof). Thus, although the auction led to many new entrants and the expansion of the footprint of some of the incumbent regional players, such as Leap and Metro PCS, no new entrant managed to capture significant spectrum in major markets. Without these key markets none of these new entrants can hope to become an effective national competitor. And, in particular, without these top geographic markets, it would be difficult for a new entrant to reach the economies of scale needed for innovative business models that lower cost to the consumer and gain market share.

VII. CONCLUSIONS

M2Z's Application presents the Commission with a unique opportunity. Its business plan would provide a subscription free broadband service to most of the country and a low cost premium broadband product, which would be of significant national benefit. However, any application should be judged against its alternative, as the true nature of social cost is the opportunity cost of the alternative forgone. The natural alternative here would be to open a rulemaking for a band plan and then to eventually auction the spectrum. As I have shown throughout this report, M2Z's business plan has three characteristics that imply it would likely be effectively discriminated against in an open auction.

First, M2Z's service would be advertising and search sponsored, thereby subsidizing consumer access. However, these business models need a large customer base to be effective. The business plan will only work if the access provider can deliver a large enough targeted demographic to the sponsors. For this reason a business plan such as that contemplated by M2Z needs a national footprint and, hence, a national spectrum license for its model to work. If past history is a good predictor for future trends at the FCC, M2Z and any other potential entrant faces an uphill battle to attain such spectrum. Once a band plan is proposed, following past examples, the FCC will face relentless pressure to "slice and dice" the spectrum into smaller geographic licenses. If the spectrum is so auctioned, M2Z and any other similar entrant with a national footprint business plan will face the exposure problem and will be unlikely to succeed in the

auction. This being so even if they are the bidder with project that would provide the highest social value.

Second, M2Z would be an entrant with a very low priced (subscription free) product and so, unless explicitly prevented in the rulemaking, incumbents would most likely be willing to pay more than M2Z even if they are not the most efficient users of that new spectrum.

Third, the limited quantity of spectrum and the fact that it is not paired means that M2Z's business plan can only work if the license is a single contiguous 20 MHz license that allows the use of TDD technology. If a band plan is developed such that only FDD technology were allowed, then M2Z's strategy would be unviable. If the spectrum was divided into channels with guard bands, then there would be insufficient spectrum for M2Z to deploy a viable network, and the guard bands would be "dead air." Moreover, M2Z or any entrant planning to use similar spread spectrum technology faces the exposure problem, given which they would have to win all the geographic licenses for every channel in order to get enough usable spectrum to have enough through-put to deliver a viable commercial service.

Finally, an additional social cost is that the public would incur the delay in use of the 2155-2175 MHz frequency band because of the time delay of the process of developing a band plan and then an auction plan. The cost of such a delay could be significant.

For these reasons, there should be no presumption that in this case any auction mechanism, and in particular the FCC's approach of creating many geographic licenses and channels and then using the SMR auction mechanism, would result in a superior

allocation of the 2155-2175 MHz frequency band than the M2Z Application and implementation of the stated goals of Congress and the President.

_____ ___03/26/2007____

Professor Simon J. Wilkie March 26, 2007

APPENDIX ONE: SIMON WILKIE CV

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EDUCATION

Ph.D. (Economics) University of Rochester, 1990
M.A. (Economics) University of Rochester, 1988
B.Comm. Honors. (Econ) University of New South Wales, 1984

AWARDS AND FELLOWSHIPS

- California Institute of Technology Graduate Student Council: 1996-97 Mentoring Award.
- California Universities for Research in Earthquake Engineering: "Social Economic and System Aspects of Earthquake Recovery and Reconstruction," co-PI with James Beck, Caltech, and Anne Kiremidjian, Stanford, $400,000 for 1997-1999.
- National Science Foundation, SES Grant "Applied Mechanism Design," $38,113 for 2000-2002.
- National Science Foundation, PEER Grant "A Decision Theoretic Approach to Evaluating Building Specific Losses," $75,000 for 2000-2002.

APPOINTMENTS

- Executive Director, Center for Communication Law and Policy, USC Law School and: Professor of Communication, (Courtesy) The Annenberg School, University of Southern California, August 2005-
- Professor of Economics, (Courtesy) University of Southern California, October 2006-
- Senior Fellow, USC Annenberg Center for Communication March 2006-
- Senior Research Associate, California Institute of Technology, July 2002- 2005
- Chief Economist, Federal Communications Commission, Washington DC; 2002-2003
- Assistant Professor, California Institute of Technology; 1995-2002.
- Lecturer, California Institute of Technology; 1994-1995.
- Member of Technical Staff, Bell Communications Research; 1990-94.
- Visiting Assistant Professor, Columbia University; 1992-93.
- Post-Doctoral Fellow, Bell Communications Research; 1989-90.

JOURNAL ARTICLES

- "Incremental Export Subsidies," with Martin Richardson, The Economic Record, March 1986, pp. 88-92.
- "The Bargaining Problem Without Convexity: Extending The Egalitarian and Kalai-Smorodinsky Solutions," with John Conley, Economics Letters, 1991, Vol. 36, pp. 365-369.
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- "Investment in New Technology as a Signal of Firm Value Under Regulatory Opportunism," with Yossef Spiegel, Journal of Economics and Management Strategy, 1996, Vol. 5, pp. 251-276.
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- "Double Implementation of the Ratio Solution by a Market Game" with Luis Corchón, Economic Design, 1996, Vol. 2, pp. 325-337.
- "Reference Functions and Possibility Theorems for Cardinal Social Choice Problems," with John Conley and Richard McLean, Social Choice and Welfare, 1997, Vol. 14, pp. 65-78.
- “Implementation of the Walrasian Correspondence by Market Games,” with Carmen Beviá, and Luis C. Corchón, Review of Economic Design, 2003, Vol. 7, pp. 429-442.
- “Current Regulatory Realities: Overcoming the Regulatory Quandary,” Michigan State DCL Law Review, 2003 Issue 3 pp. 599-605.
- “Economic Analysis at the FCC,” with Mark Bykowsky, Jonathan Levy, William Sharkey and Tracy Waldon, Review of Industrial Organization, 2003, Vol. 23, pp. 157-174.
- “Introduction to the Special Issue on Telecommunications,” Journal of Public Economic Theory, 2004, Vol. 6, pp. 537-539.
- "Endogenous Games and Mechanisms: Side Payments Among Players," with Matt Jackson, Review of Economic Studies, 2005 Vol. 72 pp. 544-566.

- “Open Networks, the Role of Regulation and Competition,” 2004, forthcoming in Journal of Telecommunications and High Technology Law.”
- “Sequencing Lifeline Repairs after an Earthquake,” with Marco Casari The Journal of Regulatory Economics. 2005 Vol. 27, pp. 47-65.
- "Credible Implementation," with Bhaskar Chakravorti and Luis Corchon, Games and Economic Behavior, 2006, Vol. 57, pp. 16-36.
- "Axiomatic Foundations for Compromise Theory: The duality of Bargaining Theory and Multi-Objective Programming," with John Conley and Richard McLean, forthcoming, Games and Economic Behavior.
- "Lies, Damned Lies and Political Campaigns," with Steve Callander, Games and Economic Behavior, at press.

OTHER PUBLICATIONS

- "Economic Policy In the Information Age," Engineering and Science, Vol. LXIV, No 1. 2001. Pp. 28-37.
- "Memorial to Jeffrey Scott Banks," Journal of Public Economic Theory, 2001, Vol. 3 No. 4, pp. 551-554.
- "Local Competition and Universal Service," with Charles Plott, Jobs and Capital, 1995 Vol. 4, pp. 43-45.
- "Installment Payments and the FCC Spectrum Auctions." Jobs and Capital, 1996, Vol. 5, pp. 26-29.

PROJECT REPORTS

- "Decision Support Tools for Earthquake Recovery: Interim Report," with Jim Beck Anne Kiremidjian, and S. King, Y. Achkire, R. Olson, J. Goltz, K. Porter, A. Irfanoglu, M. Casari, J.M Legrue, F. Boehmke and A. Gonzales CUREe-Kajima Project Report 1999.

- "Decision Support Tools for Earthquake Recovery: Final Report," with Jim Beck Anne Kiremidjian, and S. King, R. Olson, J. Goltz, T. Salmon, A Mason, K. Porter, and A. Irfanoglu CUREe- Kajima Project Report, 2000.

PROFESSIONAL ACTIVITIES

- Editorial Board Member: Journal of Public Economic Theory, 1997- present.
- Editorial Board Member: International Journal of Communications, 2006-.
- Guest Editor, Journal of Public Economic Theory Vol. 6 No. 4, October 2004.
- Referee: National Science Foundation, The American Economic Review, Econometrica, Economic Design, Economic Theory, European Transactions on Telecommunications, Games and Economic Behavior, The International Economic Review, The International Journal of Game Theory, The Journal of Economics and Management Strategy, The Journal of Economic Theory, The Journal of Economic Behavior and Organization, The Journal of Industrial Economics, The Journal of Regulatory Economics, Telecommunication Systems, and Theory and Decision.
- Committee Memberships: Program Committee, Telecommunications Policy Research Conference (TPRC): 2006-2008. Local Committee: 2002 Social Choice and Welfare Society Meetings, Pasadena. Session Chair: 1997 Summer Meetings of the Econometric Society. Member of the Organizing Committee: “Workshop on Computer Science and Game Theory,” section of the Fourth International Conference on Game Theory, SUNY Stony Brook, July 28-30, 1993. “Workshop on Implementation,” section of the Third International Conference on Game Theory, SUNY Stony Brook, July 8-10, 1992. “Workshop on Cost Allocation and Transfer Pricing,” section of the Second International Conference on Game Theory, SUNY Stony Brook, July 8-10, 1991.

Attachment B

Center for American Progress

The Failure of FCC Spectrum Auctions

Gregory F. Rose
Mark Lloyd

Progressive Ideas for a Strong, Just, and Free America

The Failure of FCC Spectrum Auctions

Gregory F. Rose
Mark Lloyd

May, 2006

The Failure of FCC Spectrum Auctions

Gregory F. Rose and Mark Lloyd

Executive Summary

The Federal Communications Commission's auctioning of spectrum licenses is a failure. The auctions have been subject to collusion and manipulation by big business, and as a result have failed to meet legislative guidelines. Until the FCC can demonstrate that it can conduct auctions in the public interest, Congress should halt the ongoing plans to auction licenses to the public spectrum.

In 1993 Congress gave the Commission authority to use competitive bidding to choose from among two or more mutually exclusive applications for an initial license. Prior to this the Commission mainly relied upon comparative hearings and lotteries to select a licensee from a pool of mutually exclusive applicants for a license. In the Balanced Budget Act of 1997, Congress extended and expanded the FCC's auction authority.

Congress set multiple goals for spectrum auctions, as the Congressional Budget Office pointed out:

> *In designing auctions for spectrum licenses, the FCC is required by law to meet multiple goals and not focus simply on maximizing receipts. Those goals include ensuring efficient use of the spectrum, promoting economic opportunity and competition, avoiding excessive concentration of licenses, preventing the unjust enrichment of any party, and fostering the rapid deployment of new services, as well as recovering for the public a portion of the value of the spectrum.*[1]

According to a rigorous economic analysis of the last ten years of FCC auctions by Dr. Gregory Rose, an expert in game theory, the FCC has failed to meet many of the congressional goals.

Efficiency and Maximizing Receipts

Despite legislative direction not to focus on maximizing receipts, proponents of FCC spectrum auctions suggest the competitive bidding structure is justified because it is both economically efficient and revenue maximizing. Detailed analysis of the 58 auctions thus far completed shows that the claim regarding maximizing receipts is false and the claim of efficiency is at best an illusion.

The Commercial Spectrum Enhancement Act requires the Government Accountability Office (GAO) to examine the FCC's commercial spectrum licensing process.[2] In addressing this requirement GAO conducted a literature review, organized limited "stakeholder" panels, and generally glossed over areas of disagreement.[3] The GAO relies on and repeats the FCC assertion that the auction of licenses for spectrum use is successful for two main reasons: 1) auctions are more efficient than either comparative hearings or lotteries, and 2) auctions raise revenue.

By efficient the FCC and the GAO seem to mean that auctions take into account market price where lotteries and comparative hearings do not, and that they are less of an administrative burden.[4] As Rose demonstrates, however, the FCC spectrum auctions are fraught with price distortions both as a result of FCC mispricing and tacit manipulation in the bidding process. The notion that an administrative process that is clearly flawed is justified because it is speedy cannot be supported.

The second rationale advanced by GAO and the FCC that the competitive bidding process contributes additional dollars into the U.S. Treasury is true, but that does not mean that the additional dollars are commensurate with the value of the spectrum. In a highly influential 1995 column, former Nixon aide and *New York Times* columnist William Safire expressed alarm over the federal budget deficit, and the solution he saw to this looming crisis was spectrum auctions.

> *Based only on current uses, which are primitive, the market value of the VHF, UHF, cellular, broadband and narrowband spectrum ranges around $120 billion.*
>
> *But in the near future, your television set will combine with your computers and telephone and fax machine into a single unit you can hang on the wall or fold up in your pocket. That's soon – possibly in the next Presidential term.*
>
> *I've seen not-for-attribution estimates that the market value of the digitized spectrum in that onrushing era will be – hold your breath – a half-trillion dollars, give or take a hundred billion.*[5]

While the federal budget projected a surplus at the end of the Clinton Administration, the budget deficit has ballooned again. Assuming Safire wrote this with some basis, FCC spectrum auctions have not come close to the half-a-trillion dollars desperately needed now to close the budget deficit again. Revenue from spectrum auctions so far is in the $45 billion range and the Congressional Budget Office and the Bush White House guesstimate that after a slight dip in 2008 auctions will raise perhaps another $6-10 billion through 2015. At a time when the revenue is badly needed, we have not come close to receiving a fair market value for the spectrum licenses auctioned thus far.

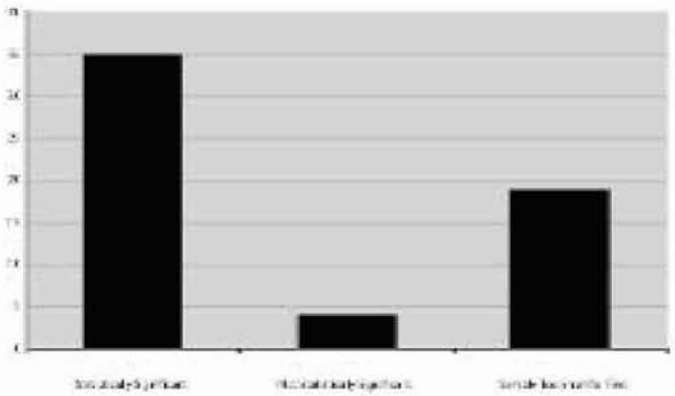
According to Rose, there is evidence that considerably less revenue has been raised than might otherwise have been the case. Large-scale mispricing by the FCC has resulted in failure to raise expected revenue or allocate licenses in over 36 percent of auctions. Further reduction of potential revenue results from the ability of bidders to adopt manipulative strategies of tacit collusion or preemptive bidding. Both of these strategies result in the auctioning of licenses at significantly lower prices to the manipulating bidders than to those who do not employ these strategies. Collusion does not generally result in a fair auction where the winning bids are commensurate with the value of auctioned item. Furthermore, significant amounts of revenue have been generated by a handful of auctions, an artifact both of genuinely different valuations for different bandwidths and of the way in which FCC rules determine qualifying bidders.

Imagine Christie's selling a million-dollar Picasso to a wealthy collector for one hundred dollars but claiming success because it was an easy and quick sale and the money is in the bank. As Dr. Rose notes, if a private auction house did as poor a job as the FCC in returning value to the sellers, that auction house would be out of business.

A Chance for Entrepreneurs?

The legislator perhaps most responsible for pushing through the 1996 Telecommunications Act was former Senator Larry Pressler. Pressler argued: "We have a responsibility to stand up to special interests and to auction off those portions of the spectrum that will provide new uses and will provide billions of dollars for the taxpayers of this country." [6] While we cannot be absolutely certain who Senator Pressler was referring to by the term "special interests," a substantial portion of the public record suggests that many members of Congress were very concerned to avoid the concentration of licenses and to provide opportunities to small entrepreneurs.

# of Auctions in Which There Is a Statistically Significant Difference in the Average Number of Licenses Assigned to the Top Five Bidders and the Bottom Five Bidders



* There are thirty-five auctions in which the difference is significant at alpha < .001, one auction in which the difference is significant at alpha < .01, and one auction in which the difference is significant at alpha < .05. In 19 auctions there was too small a sample.

Even the rosy GAO report notes that "some industry stakeholders we interviewed stated that auctions limit participation to large companies," yet GAO has not conducted an analysis of this issue. Dr. Rose's careful analysis of the auctions reveals a significant skew of auction outcomes have favored a small subset of bidders – and those bidders are not small entrepreneurs. There is a tendency for some bidders to prevail in multiple auctions, and there has been a measurable increase in the market power of large media corporations. Furthermore, the FCC procedure of simultaneous, multi-stage auctions over multiple items is subject to manipulation by tacit collusion among bidders, avoidance of head-to-head competition by the best capitalized and most successful bidders, and preemptive bidding strategies. This results in the wealthy bidders winning valuable rights to spectrum at significantly lower prices than other bidders.

The bar graph above shows the number of auctions in which the difference in average number of licenses obtained by the top five bidders and the bottom five bidders is statistically significant:[7]

A Chance for Women and Minorities?

Finally, while Congress specifically mandated that the FCC use spectrum auctions to increase economic opportunity for small businesses, women and minorities, there is no evidence that these auctions have significantly increased opportunity for any of these "designated entities." An independent study funded by the FCC indicates that "minority and women applicants were less likely to win at least one license than were non-minority applicants [and] Minorities and women qualified for auctions at significantly lower rates than non-minorities."[8]

Measured across all wireless auctions through 1999, minority and women applicants were less likely to win at least one license than were non-minority applicants. Indeed, studies commissioned by the FCC itself point to the failure of small businesses, women and minorities to qualify and to successfully participate in spectrum auctions.

The fact that barriers continue to exist limiting the participation of women and minorities has not been resolved by the FCC. Indeed, as a problem in need of solution, this goal has simply been forgotten.

Concerned that "sham buyers" were taking unfair advantage of the designated entity (DE) rules, the Commission changed its auction rules in April 2006 by "eliminating the payoff for this 'flipping' of licenses," according to Commissioner Michael Copps.[9] Still, the new rules do not prohibit DEs from having "material relationships" with larger corporations nor did they even address the problem of limited minority ownership or deployment of advanced services to minority communities. In addition the new auction rules don't address the threat of big company retaliation against smaller firms that might compete in subsequent auctions.

Three Strikes

The FCC does not know how to conduct auctions in accordance with clear legislative goals. Congress should put an end to this.

In sacrificing the public interest in pursuit of hypothetical market efficiencies and greater revenue, we have arrived at the worst of both worlds: FCC spectrum auctions neither serve the public interest nor realize the promised economic efficiencies and revenue maximization touted by their advocates. As Congress contemplates releasing the so-called analog spectrum to FCC auctioning, it should demand a demonstration that the FCC can stop the collusion, achieve fair market value, and overcome the barriers experienced by women and minorities. In short, until the FCC can conduct auctions in the public interest it should stop distributing public property.

Introduction[1]

As a result of authorization by Congress in the Omnibus Budget Reconciliation Act of 1993, since 1994 the Federal Communications Commission (FCC) has conducted 58 auctions of licenses for electromagnetic spectrum. Based in part on the FCC's initial experiences with such auctions, the Balanced Budget Act of 1997 mandated the use of auctions to resolve mutually exclusive applicants for initial licenses in all but a handful of exempted categories.[2] As the Congressional Budget Office points out,

> *In designing auctions for spectrum licenses, the FCC is required by law to meet multiple goals and not focus simply on maximizing receipts. Those goals include ensuring efficient use of the spectrum, promoting economic opportunity and competition, avoiding excessive concentration of licenses, preventing the unjust enrichment of any party, and fostering the rapid deployment of new services, as well as recovering for the public a portion of the value of the spectrum.*[3]

The adoption of auction for assignment of spectrum licenses to applicants was primarily justified on the grounds that auctions produce more efficient outcomes in terms of competition, rational exploitation of complementarities, availability of technologies to the public, and revenue maximization.

The following analysis demonstrates that the FCC auctions of licenses to use the spectrum do not meet the requirements established by Congress. They do not ensure "efficient use of the spectrum," and rather than promote "economic opportunity and competition" they have resulted in an "excessive concentration of licenses." Moreover, there is little evidence that this process has fostered the "rapid deployment of new services." And while there has been some recovery of "a portion of the value of the spectrum," it is not at all certain that auctions return to the Treasury a value close to their worth. This paper will examine each of these points in turn.

Background

Prior to the approval of spectrum auctions, the FCC assigned spectrum through comparative hearings in which the merits of two or more competitors for a single license were evaluated and a decision to allocate to one of them was made on the basis of how well an applicant made efficient use of spectrum and met the demands of the "public interest." Although the determination of the public interest was not clearly defined, it remained the more important criterion. The comparative hearing method involved three rounds of agency decision-making: before an FCC administrative law judge, the Review Board, and the Commissioners themselves, plus the possibility of review by the Court of Appeals. Lotteries were also used to allocate the first cellular telephone service licenses, although lotteries led to speculation in spectrum and resale, requiring new rule-making and extensive dispute resolution and frequently resulting in profoundly inefficient outcomes. Even today the majority of bandwidth is still assigned under comparative hearing decisions, although gradually the auction process is being applied to more and more bandwidth.

Before discussing the extent to which spectrum auctions have met the criteria which were used to justify their adoption, it is useful to briefly review how FCC spectrum auctions are conducted and what has been auctioned. FCC spectrum auctions are designed to be what are called Standard English Auctions, i.e., simultaneous, multi-round auctions in which all licenses are available for bidding in each round.[4]

Roughly four to six months prior to each auction the FCC initiates a series of steps designed to inform the public of the availability of the spectrum to be auctioned and the procedures which the auction will follow and to provide education to potential and actual bidders to familiarize them with the auction process. The FCC also obtains the refundable deposit which is used by a bidder to purchase bidding units required to bid in the auction. Before an auction begins the FCC designates a reserve price for each license, i.e., the price below which the license will not be auctioned. Failure of bidders to meet the reserve price results in FCC retention of the license unless the FCC waives the reserve price during the auction. Reserve prices have been a particularly troublesome point for the FCC, resulting in large numbers of licenses which remain in FCC hands after completion of an auction because no bidder met the reserve price. As we shall see below, this suggests that the FCC reserve price system significantly misprices such licenses.

The auctions are conducted electronically using a secure system. The duration of a round is established by the FCC prior to commencement of the auction, and at the conclusion of each round the results are announced, giving the bidders information about the value attached to each license by the other bidders. Bidding continues until there is a round in which no further bids are submitted. In some cases the FCC authorizes what is known as "package bidding," i.e., the ability of bidders to bid on groups of licenses as well as individual licenses, usually in cases in which the FCC recognizes complementarities among the licenses which affect the value of the licenses as a group. For example, in the case of auction 5 (Broadband PCS C Block), the filing date for bidders was November 6, 1995; the pre-auction seminar was held on November 29, 1995. Upfront payments were due by December 1, 1995. Two hundred and twenty-five bidders qualified for the auction, bidding on 493 licenses, each authorizing service on frequency block C on 30MHz of bandwidth; this auction was designed for small business owners to compete. This auction was completed in 184 rounds over 83 days from December 18, 1995 to May 6, 1996, with bidders able to bid on licenses in each round until a round in which there were no further bids. Two bidders later defaulted on 18 licenses.

Economic Efficiency: Indices of Market Competition in FCC Spectrum Auctions

Promotion of competition is frequently touted as a principal benefit arising from the use of auctions to assign electromagnetic spectrum. Competition in these cases can be conceptualized in two ways: do the outcomes produced by the auction system enhance competition within the telecommunications industry generally[5] and does the auction process itself significantly exhibit the signs of real competition among bidders? On close examination of the actual data from spectrum auctions conducted by the FCC since 1994, claims for either outcome or process competition seem largely unfounded.

There are several ways to evaluate the degree to which FCC spectrum auctions enhance or diminish competition in the telecommunications industry. Of principal concern is the extent to which such auctions occasion market concentration on a scale which erects significant

barriers to entry and permits the exercise of market power to shape price. This is all the more important because of the tendency for the telecommunications industry to exhibit high levels of concentration historically. This paper proposes to look at four such measures: the percent of bidders in any auction acquiring 50 percent or more of auction items versus the percent of bidders acquiring any auction items; the mean number of licenses/permits acquired by the top five bidders versus the mean number of licenses/permits acquired by the remaining bidders; a chi-square test of the difference between the observed mean number of licenses acquired by the top five bidders and the expected mean number of licenses acquired by the top five bidders under conditions of perfect competition; and the Hirschman-Herfindahl Index of market concentration. Table 1 presents the results of these measures.

The outcomes of FCC spectrum auctions show a high degree of skew toward acquisition of 50% or more of auction items by a relatively small number of bidders. In only 15.52%[6] of auctions did a small subset of bidders fail to acquire at least 50% of items auctioned. The more competitive outcome of 50% of bidders acquiring 50% or more of auctioned items occurred in only 5.17% of auctions. Much more troubling is the evidence that very small subsets of bidders tended to acquire numbers of licenses/permits totally out of proportion to competitive expectations: 1-10% of bidders acquired 50% or more of licenses/permits in 43.10% of auctions, 11-20% of bidders acquired 50% or more of licenses/permits in 27.59% of auctions, 21-30% of bidders in 6.90% of auctions, and 31-40% of bidders in 1.72% of auctions. The mean percentage of bidders acquiring 50% or more of auction items over all FCC spectrum auctions was 11.26%. In other words, barely more than 10% of bidders were routinely able to acquire 50% or more of the available licenses/permits. Examining the situation in terms of the percentage of bidders who acquired any auction items is somewhat more promising. In only 12.07% of auctions did all bidders acquire at least one license/permit. However, in 53.45% of auctions between 51% and 100% of bidders acquired at least one item. This still leaves 46.55% of auctions in which 50% or less of bidders acquired at least one item. On average 58.19% of bidders acquired at least one license/permit. This comparison allows us to establish one pattern across FCC spectrum auctions: they tend to be dominated by a small subset of bidders who acquire a majority of auction items while other bidders typically obtain only a handful of licenses/permits, if that. This finding is supported by analysis of the mean number of auction items obtained by the top five bidders in comparison to the mean number of auction items obtained by the remaining bidders.

In the 38 auctions analysis of the mean number of auction items obtained by the top five bidders in comparison to the mean number of auction items obtained by the remaining bidders is appropriate.[7] The mean number of auction items obtained by the top five bidders reinforces the impression of a high degree of skew toward such bidders: in 24.64% of such auctions the top five bidders obtained an average of more than 100 licenses/permits each, in 2.57% 81-100, in 7.69% 61-80, in 7.69% 41-60, in 17.95%, 21-40, and in 38.46% of auctions 1-20 items. On average the top five bidders received a mean of 85.82 auction items. Examination of the mean number of auction items obtained by the remaining bidders reveals a similarly staggering skew: in 30.77% of such auctions the remaining bidders acquired on average less than one license/permit, in 51.28% between 1 and 5 auction items, in 7.69% 6-10 items, in 5.13% 11-15 items, in 2.565% 16-20 items, and in 2.565% 21-25 auction items. On average the remaining bidders received a mean of 3.43 auction items. These findings are consistent with the existence of a strong skew biasing auction outcomes in favor of a small subset of bidders.

It remains to determine if this strong skew in favor of a small subset of bidders is statistically significant. The chi-square test of goodness of fit measures the degree to which an observed distribution differs from a theoretical distribution.[8] In this case the observed distribution is the number of auction items obtained by the top five bidders; the distribution is the distribution of auction items obtained by the top five bidders under the assumption of perfect competition, i.e., equiprobability of success in an environment of perfect information and symmetrical resources. In 84.62% of auctions to which this test was applied the difference was significant at $a < .001$, in 2.56% of auctions it was significant at $a < .01$, and in 2.56% of auctions it was significant at $a < .05$. In 10.26% of auctions to which this test was applied no significant difference was found. Thus, in the overwhelming majority of FCC spectrum auction outcomes there has been a statistically significant bias in favor of a relatively small subset of bidders.

Even with this statistically significant bias it is still possible that the degree of market concentration produced by this bias is less than apparent because of the possibility of relatively large sets of bidders who are at least marginally successful in obtaining auction items. In order to explore this hypothesis let us assume that each auction amounts to a market in that particular bandwidth of spectrum, i.e., that the distribution of licenses over the successful bidders indicates market share.[9]

The Hirschman-Herfindahl Index (HHI) is a common measure of market concentration which is particularly sensitive to the number of actors in the market and can, therefore, indicate where the breadth of the distribution of licenses/permits mitigates the concentration effects of the already observed biasing skew.[10] The HHI is also useful in this case because it allows examination of auctions in which the number of auction items or the number of bidders was too small for a significant chi-square test. The U.S. Department of Justice uses the HHI in evaluating antitrust actions, regarding an HHI < 1,000 as indicating a competitive market, an HHI ≤ 1,000 to 1,800 as indicative of a moderately concentrated market, and an HHI >1,800 as indicative of a highly concentrated market. In 24.14% of FCC spectrum auctions HHI < 1,000 occurs; in 13.79% of auctions an HHI between 1,000 and 1,800 occurs, while in 62.07% of these auctions an HHI > 1,800 occurs. This suggests that while the breadth of distribution of licenses in roughly 24% of auctions reduces the danger of market concentration, in nearly 76% of FCC spectrum auctions moderate to high concentration still occurs.

TABLE 2	Low HHI	Mod. HHI	High HHI
Low Skew Bias	-	2.94	7.89
Moderate Skew Bias	-	-	5.26
High Skew Bias	36.84	15.79	31.58

Table 2 summarizes the findings by relating the degree of skew biasing outcomes in favor of the five top bidders to the HHI for each auction. While it is clear that the breadth of distribution of licenses/permits in some auctions mitigates some of the market concentration effect even in the presence of significant skew favoring the top five bidders, it remains disturbing that 37 of 38 auctions examined score high in market concentration on at least one of the indices. This suggests strongly that outcome competition is not characteristic of FCC spectrum auctions and these auctions fail to enhance competition general in the telecommunications industry.

TABLE 3 Firm	# Licenses Assigned	Auction
Nextel Spectrum Acquisition Corp.	3437	33, 34, 36, 38, 43
WinStar Wireless Fiber Corp.	931	30
CloudNine Wireless, LLC	843	59
Jamestown Manufacturing Corporation	698	40
Advanced Metering Data Systems, LLC	652	59
TeleBEEPER of New Mexico, INC	624	40, 42, 43, 48,
MilkyWay Communications, LLC	476	42
Nextel License Acquisition Corp.	475	16
Intelligent Trans. & Monitoring Wireless	357	59, 61
Advanced Radio Telecom Corp.	352	30
Schuylkill Mobile Fone, Inc.	333	40, 48
Agri-Valley Communications, Inc.	270	48
Space Data Spectrum Holdings, LLC	247	41, 50, 51
AT&T Wireless PCS Inc.	243	4, 11
Baker Creek Communications, L.P.	232	17
Intek License Acquisition Corp.	232	18, 24
Communications Equipment, Inc.	231	40
Progeny LMS, LLC	230	21
Geotek Communications, Inc.	181	7
Southern Communications Services, Inc	179	34, 36
FCI 900, Inc.	177	7
Hyperion Communications Long Haul, LP	177	30
Microwave Data Systems Inc.	168	42
Scott C. MacIntyre	161	40, 41, 50, 55
SprintCom, Inc.	160	11
Metrocall USA, Inc.	145	26
Zephyr Wireless, L.L.C.	140	30
Cellco Partnership d/b/a Verizon Wireless	139	35, 58
New York State Electric & Gas Corporation	138	48
Warren C. Havens	137	20, 21, 24
Jeffrey Scott Cofsky dba Texas License	136	48
Consultants	130	30
Atlantis Bidding Corp.	126	18
Net Radio Group Communications, LLC	126	7
Paging Network of America, Inc.	109	11
OPCSE-Galloway Consortium	101	41
Allegheny Communications, Inc.	100	11
Western PCS BTA I Corp.	93	6
Heartland Wireless Communications, Inc.	89	49
Aloha Partners II, L.P.	84	39
Helen Wong-Armijo	83	7
RAM Mobile Data USA, LP	82	16, 34, 36
Nevada Wireless, LLC	82	16, 59
Southern Company Services, Inc.	80	39
Telesaurus Holdings GB, LLC	79	44, 60
Aloha Partners, L.P.	79	35
Salmon PCS, LLC	78	26
Vodafone AirTouch Licenses, LLC	73	11
AllTel Mobile Communications, Inc.	68	59
Great River Energy	68	18
Nextel 220 License Acquisition Corp.	64	22
ABC Wireless, L.L.C.	63	7
Fleet Talk, INC.	63	26
WWC Paging Corp.	60	53
MDS Operations, Inc.	58	22, 35
Leap Wireless International, Inc.	56	6

A troubling additional factor in evaluating the extent to which FCC spectrum auctions contribute to market concentration in the telecommunications industry is the large number of firms which have prevailed as top five bidders in more than one auction: 31 firms have prevailed in at least two auctions, nine in at least three auctions, and five in at least four auctions. Various firms associated with Nextel prevailed among the top five bidders in seven auctions, amassing a total of 3,980 licenses. This suggests that the factors cited in the analysis above militate to advantage a number of firms across multiple auctions as well as in individual auctions. Table 3 lists the top 100 bidders in terms of number of licenses/permits acquired in FCC spectrum auctions.

Economic Efficiency: Strategic Manipulation in FCC Spectrum Auctions

Does the auction process itself significantly exhibit the signs of real competition among bidders? There are several ways of addressing this question. Table 4 provides two indices which are helpful in providing an answer. One of the factors which militates for oligopolistic rather than perfect competition in real-world markets is initial capitalization asymmetries. Actors who come to the market with fewer resources to invest, who are, therefore, more vulnerable to the vicissitudes of market fluctuation and to intimidation by stronger market actors, are significantly disadvantaged in their ability to compete. This situation also obtains in FCC spectrum auctions – some bidders come to the auction with hugely more resources to deploy strategically in pursuing acquisition of blocks of licenses than do others. However, there is a problem in that the majority of bidders are firms which are not publicly traded and it is difficult to obtain accurate information on their capitalization. It is for that reason necessary to develop a proxy variable which indirectly measures differences in initial capitalization.

TABLE 3 Firm	# Licenses Assigned	Auction
American Telecasting Development, Inc.	56	33, 34, 36, 38, 43
NextWave Personal Communications, Inc.	53	50
MAP Paging Co., Inc.	51	58
Eclipse Communications Corp.	51	46
Intek Licence Acquisition Corp.	51	59
Trumpet Corp.	48	40, 42, 45, 48,
WillyWay Broadband, LLC	46	42
ACI 900, Inc.	46	16
DTV Norwich, LLC	44	59, 61
Alaska Native Wireless, LLC	44	60
Cavalier Group, LLC	43	40, 46
DCR PCS, Inc.	42	48
NEXTBAND Communications, LLC	41	41, 50, 51
Paging Systems, Inc.	40	4, 11
Telephone & Two-Way, Inc.	40	17
WNP Communications, Inc.	39	18, 24
Repeater Work Spectrum Acquisition, Inc.	38	40
College Creek Broadcasting, Inc.	38	21
Preferred Acquisitions, Inc.	37	7
220 MHz Bidding Consortium	37	34, 36
SOUTH-COM LLC	37	7
Vista PCS, LLC	36	50
Cook Inlet/VS GSM VII PCS, LLC	36	42
Wireless One, Inc.	34	40, 41, 50, 55
OPCS Three, LLC	34	11
Pegasus Guard Band LLC	33	28
Motient Communications Co.	32	60
Actel Corp.	32	35, 58
CM Wireless Systems, Inc.	32	48
PCS Partners, LP	31	20, 21, 24
Cloustin'na Communications, Inc.	31	48
Celera Wireless, Inc.	31	50
LIN Television Corp.	28	18
Cook Inlet/VeloCitiStream PCS LLC	28	7
PCTV Gold, Inc.	28	11
WirelessCo, LP	28	41
220 MHz Auction Group	24	11
Bruce E. Fox	24	4
Vulcan Spectrum, LLC	23	49
Bell South Wireless Cable, Inc.	22	59
Cook Inlet/VS GSM V PCS, LLC	21	7
A.R.C., Inc.	21	16, 34, 36
Access Spectrum, LLC	21	14, 39
Edge Mobile, LLC	21	39
Radioactive, LLC		44, 60
		59
		26

As stated earlier, bidders in FCC spectrum auctions are required to place a refundable deposit with the FCC which determines the number of bids the bidder may place in the auction. While there are factors other than just initial capitalization which affect the amount a bidder may deposit, i.e., the bidder may be interested in acquiring only a small subset of the available spectrum, this deposit primarily reflects the resources the bidder brings to the auction and can strategically deploy in the bidding process. Thus comparison of the mean upfront deposit of the five most successful bidders to that of the five least successful bidders in an auction provides a proxy measure of the range of initial capitalization asymmetry in the auction. There are 33 FCC spectrum auctions in which the number of bidders and items at auction are sufficiently large to permit reliable analysis of the ratio of the mean upfront deposit of the top/bottom five bidders in the auction. Only in one auction (auction 59, Multiple Address Systems) does this ratio favor the bottom end of the distribution. In the remaining 32 (96.97%) relevant auctions the ratio decidedly favors the bidders who prove to be most successful in the auction. The ratio ranges from 1.26 to 186.76; obviously the larger the ratio, the greater the putative initial capitalization asymmetries in a given auction. The mean ratio for all 33 auctions is 46:64. A Student's paired, two-tailed t-test of the difference of the means of the two distributions underlying the ratio was significant at $\alpha = .0167$, which strongly implies that a very real difference is measured by the ratio. That significant initial capitalization asymmetries exist between bidders in these auctions and that the asymmetries significantly favor those bidders who eventually prevail is evidence that competition within the auctions is negatively affected by these facts. As will be shown below, such asymmetries make available strategies – particularly preemptive bidding – to a subset of bidders which can systematically reduce the price at which auction items are acquired.

TABLE 4

Auction Number	Type	# of Licenses at Auction & Actually Asgn'd.	Number of Bidders	% of Licenses Acquired in 1st Round	Ratio of Mean Upfront Deposit Top/Bottom 5 Bidders
1	PCS Narrowband Nation	10	29	0.00	NDA
2	IVDS	594	289	0.00	NDA
3	PCS Narrowband Region	130	28	0.00	1.26
4	PCS A&B Block	99	30	0.00	1.69
5	PCS C Block	493	255	0.00	28.55
6	MDS	493	155	0.00	92.60
7	900 MHz SMR	1020	123	3.63	112.21
8	DBS (110W)	1	3	0.00	-
9	DBS(148W)	1	2	0.00	-
10	PCS Block C Reauction	18	32	0.00	7.79
11	PCS D,E, F Block	1479(1472)	153	1.70	25.02
12	Cellular Unserved	14	22	28.57	3.00
14	WCS	126	24	31.75	81.19
15	DARS	4	2	0.00	-
16	800 MHz SMR	525(524)	62	5.73	16.19
17	LMDS	986(864)	139	11.26	34.00
18	220 MHz	908(693)	54	18.61	81.90
20	VHF Public Coast	42(26)	8	0.00	-
21	LMS	528(239)	5	0.00	-
22	PCS	347(302)	57	10.93	33.12
23	LMDS	161	90	0.00	6.65
24	220 MHz	225(222)	18	0.00	9.40
25	Closed Broadcast	115	242	13.04	10.94
26	929 and 931 Paging	2499(985)	81	70.46	48.51
27	Broadcast	1	3	0.00	-
28	Broadcast	2	4	0.00	-
30	39 GHz	2175	35	28.87	4.16
32	AM Broadcast Stations	3	5	0.00	-
33	Upper 700 MHz Guard	96	15	0.00	2.62
34	800 MHz SMR General	1053(1030)	26	6.70	62.15
35	PCS C&F Block	422	87	0.00	185.39
36	800MHz SMR Lower	2800	28	60.82	51.20
37	FM Broadcast	288(258)	456	1.55	16.76
38	Upper 700 MHz Guard	8	5	25.00	-
39	Public Coast & LMS	257(217)	7	52.53	-
40	Paging	15514(5323)	193	36.88	186.76
41	Narrowband PCS	365(317)	9	2.21	-
42	Multiple Address Sys	5104(878)	13	64.24	24.76
43	Multi-Radio Service	27	7	0.00	-
44	Lower 700 MHz band	740(484)	125	24.38	28.26
45	Cellular RSA	3	7	0.00	-
46	1670-1675 MHz Band	1	2	0.00	-
48	Lower & Upper Paging	10202(2832)	104	50.46	28.72
49	Lower 700 MHz Band	256(251)	56	2.79	183.57
50	Narrowband PCS	48	4	2.08	-
51	Narrowband PCS	5	2	0.00	-
52	Direct Broadcast Satellite	3	2	0.00	-
53	MVDDS	214(192)	14	8.33	25.47
54	Closed Broadcast	4	6	0.00	-
55	900 MHz SMR	55	17	7.27	6.38
56	24 GHz	880(7)	3	57.14	-
57	AMTS	20(10)	4	90.00	-
58	Broadband PCS	242(217)	35	6.45	136.98
59	Multiple Address Systems	4226(2223)	31	35.36	0.41
60	Lower 700 MHz Band	5	5	0.00	-
61	AMTS	10	7	0.00	-
80	Blanco, Texas Broadcast	1	11	0.00	-
82	New Analog Television	4	11	0.00	1.42

Another index of competition within an auction is the percentage of licenses/permits which are acquired by a bid in the first round of the auction. Acquisition of an auction item with a bid placed in the first round signals either the absence of a competitor to bid for the item or a preemptively high bidder which intimidates other bidders from entering competition for the item. In 29 (50%) of the 58 FCC spectrum auctions which have been conducted to date, auction items were acquired with a bid placed in the first round. The percentage of auction items acquired in this fashion ranges from 1.55% (auction 27, FM Broadcast) to 90% (auction 57, AMTS) with a mean of 13.08% over all the auctions. This is particularly disturbing evidence of non-competitive behavior in FCC spectrum auctions, particularly when contextualized with what we shall see below is an alarmingly high number of licenses at auction which never receive any bid whatsoever.

Collusive behavior is yet another indicator of non-competitive dynamics at work in the FCC spectrum auctions. In 2000 Peter Cramton and Jesse Schwartz examined such behavior in auction 11, the PCS D, E, F Block auction.[11] The problem which they identified was that fact that

> *[d]uring the DEF auction (the Personal Communications Service (PCS) auction for broadband frequency blocks D, E, and F) the FCC and the Department of Justice observed that some bidders signaled each other with code bids. A code bid uses the trailing digits of the bid to tell other bidders on which licenses to bid or not bid. Since bids were often in the millions of dollars, yet were specified in dollars, bidders a negligible cost could use the last three digits — the trailing digits — to specify a market number. Often, a bidder (the sender) would use these code bids as retaliation against another bidder (the receiver) who was bidding on a license desired by the sender. The sender would raise the price on some license the receiver wanted, and use the trailing digits to tell the receiver on which market to cease bidding. Although the trailing digits are useful in making clear which market the receiver is to avoid, retaliating bids without the trailing digits can also send a clear message.*[12]

They also found that

> *six of the 153 bidders in the DEF auction regularly signaled using code bids or retaliating bids. These bidders won 476 of the 1,479 licenses for sale in the auction, or about 40% of the available spectrum in terms of population covered. These signaling bidders paid about the same as other bidders for the F-block licenses, but on the D and E blocks, the signaling bidders paid $2.50/person, where as nonsignaling bidders paid $4.34/person. Moreover, when we control for market characteristics, we find that bidders that used code bids or retaliating bids paid significantly less for not only the D and E licenses, but also for the F licenses. We take this as evidence that the bid signaling strategies were effective at keeping prices low on the collection of licenses desired by the signaling bidders.*
>
> *Further, there was a tendency for bidders to avoid bidding against AT&T, a large bidder with a reputation for retaliation. Bidders frequently bid substantially more for an identical license, rather than bid on the cheaper license held by AT&T.*[13]

To anyone who has followed the game theoretic literature analyzing behavior in Standard English Auctions, the findings of Cramton and Schwartz should be unsurprising. The work of Engelbrecht-Wiggins and Kahn[14] and of Brusco and Lopomo[15] has demonstrated that the auction design adopted by FCC spectrum auctions is particularly susceptible to tacitly collusive manipulation by bidders through signaling. Both studies have identified the existence of equilibria in which bidders can coordinate assignment of auction items at relatively low prices in auctions characterized by bidding on distinct units in sequential rounds. These equilibria are achieved through retaliation against bidders who refuse to cooperate in the assignment arrangement. It is important to note that the collusion achieved here is tacit rather than explicit. There is no need to assume prior communication and negotiation of the assignment arrangement. All that is required for tacit collusion is that the bidders recognize that self-interest is served by signaling which items they desire and which they are willing to forgo through retaliation against bids which threaten their acquisition of the items they desire. This is similar to the dynamic in oligopolistic markets in which the major actors achieve production and price equilibria which can be negotiated and enforced by the threat of punishment. It is also important to note that the dynamics of FCC spectrum auctions are somewhat more complicated than those of the game theoretic models developed by Engelbrecht-Wiggins and Kahn and of Brusco and Lopomo, since they are characterized by initial capitalization and complimentarity asymmetries as well as by the heterogeneity of auction items. In particular this implies both that collusive strategies will be somewhat more difficult to identify and that better capitalized bidders with substantial complementarities in their license acquisitions are more likely to be effective in utilizing a tacitly collusive strategy.

A related tacitly collusive strategy available in FCC spectrum auctions is the avoidance of head-to-head competition over licenses by the dominant bidders. This bidding strategy is suggested by a nearly uniform tendency observed since antitrust actions and deregulation in land-line telephony, cellular services, cable television, and broadband services, namely, avoidance of direct competition between major actors which might negatively affect profit and market share. To be sure, some of this phenomenon arises from the existence of complementarities arising from the technological need for geographical contiguity. However, analysis of two randomly selected FCC spectrum auctions in which head-to-head competition between the dominant bidders was examined while controlling for geographic contiguity (auction 43 – Multi-Radio Service – and auction 25 – Closed Broadcast) showed significant patterns of avoidance.

It should be kept in mind that the entire auction process is a series of reiterative games and in such games the likelihood of bidders learning ways in which to manipulate the bidding process is relatively high. In some cases, e.g., the classic Prisoner's Dilemma, iterative learning creates the possibility of Pareto-optimal equilibria, but such games are structurally different from the games which model auctions (i.e., the Pareto-optimal outcome necessitates collusion in the form of tacit agreement) and there is neither good theoretical nor empirical reason to believe that the sequential equilibria of auction games are impervious to anti-competitive collusive bidder manipulation.[16]

Economic Efficiency: An Abject Failure of Competition in FCC Spectrum Auctions

Analysis of market power relations arising from outcomes in FCC spectrum auctions reveals the claim of increased economic efficiency in the form of increased competition put forward to justify adoption of the auction policy is simply not supported by the evidence. The evidence of a strong skew in favor of a small subset of bidders, the confirmatory evidence of the HHIs associated with each auction, and the number of bidders who have prevailed in multiple auctions all point inevitably to FCC spectrum auctions as engines for the production of market competition in the telecommunications industry. The examination of strategic manipulation in FCC spectrum auctions has disclosed evidence of behaviors which systematically limit competition in the auction process. It is no exaggeration to suggest that oligopolistic competition characterizes most FCC spectrum auctions based on the evidence of capitalization asymmetries, first round acquisitions, and tacitly collusive bidding strategies. Bluntly, a substantial element of the rationale on which Congress based authorization of these auctions was little more than blue smoke and mirrors.

Revenue Maximization and FCC Spectrum Auctions

It is one of the ironies of the way in which FCC spectrum auctions evolved that the economic theorists who designed them tend to emphasize justifications on grounds of economic rationality or efficient allocation of resources and to denigrate claims that revenue maximization was ever a major factor in their thinking, while the politicians who authorized them have embraced revenue maximization with a vengeance. As Eli Noam acutely observed,

> *The underlying objective for the auction "game" is to raise revenues for government. This is usually denied quite heatedly, and other considerations are cited, such as moving spectrum to the users valuing it most, etc. But the political fact is that auctions were finally approved, after years of opposition to them by powerful Congressional barons and the broadcast industry, as a measure to reduce the budget deficit and avoiding spending cuts and tax increases. Allocating spectrum resources efficiently was a secondary goal in the political process. The maximizing function may have been constrained in several ways, such as by rules against monopoly control and in favor of diversity. But these additional policy considerations were only the fig leaf on the main reason, raising money for the empty coffers of the Federal Government. The rest is merely technique. Conceived in the original sin of budget politics rather than communications policy, spectrum auctions are doomed to serve as collection tools first and allocation mechanism second.*[17]

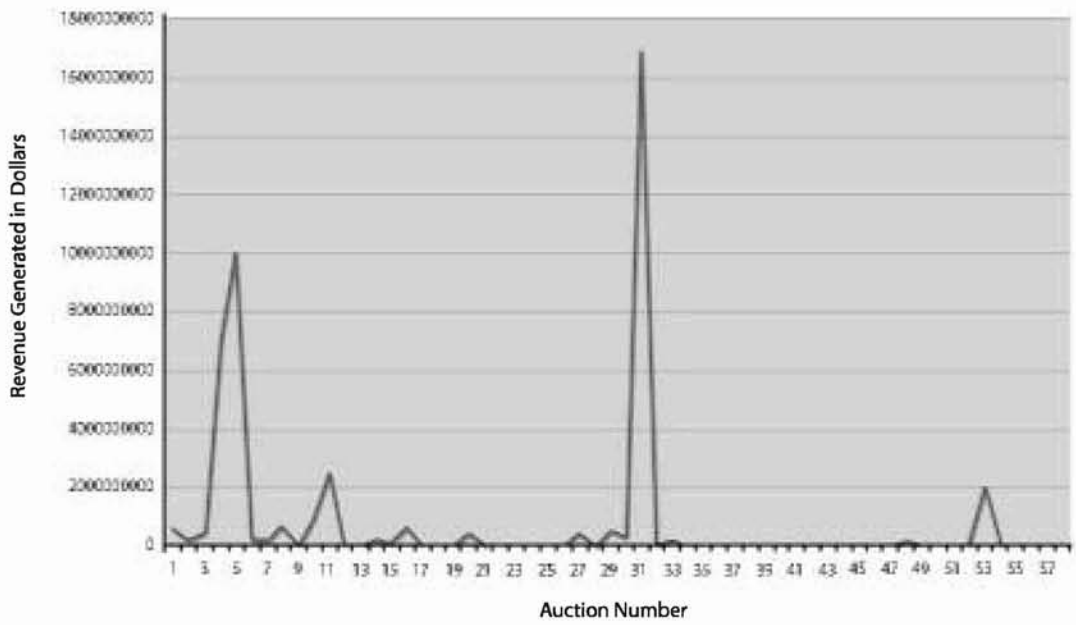
On the face of it, FCC spectrum auctions have been veritable engines for making money for the federal government. To date FCC spectrum auctions have raised slightly over $45 billion. Table 5 provides the revenue per auction and the revenue per license for each auction. However, the total revenue figure is somewhat misleading. When you examine the auction revenue figures over time, it becomes apparent that a small number have generated most of the revenue, while the others generate vastly less revenue. Table 6 provides a graphic illustrating this. This pattern in revenue-generation is an artifact both of genuinely different valuations for different bandwidths and of the way in which FCC rules shape the qualifying bidder set.

TABLE 5

Auction Number	Type	# of Licenses at Auction & Actually Asgn'd.	Number of Bidders	% of Licenses Held by FCC at End of Auction	Revenue in $	Mean Revenue Per License
1	PCS Narrowband Nation	10	29	0.00	617,006,674.00	61,700,667.40
2	IVDS	594	289	0.00	213,892,375.00	360,088.17
3	PCS Narrowband Region	130	28	0.00	392,706,797.00	3,020,821.52
4	PCS A&B Block	99	30	0.00	7,019,403,797.00	70,903,068.66
5	PCS C Block	493	255	0.00	10,071,708,842.00	20,429,429.70
6	MDS	493	155	0.00	216,239,603.00	438,619.88
7	900 MHz SMR	1020	123	0.00	204,267,144.00	200,261.91
8	DBS (110W)	1	3	0.00	682,500,000.00	682,500,000.00
9	DBS(148W)	1	2	0.00	52,295,000.00	52,295,000.00
10	PCS Block C Reauction	18	32	0.00	904,607,467.00	50,255,970.39
11	PCS D,E, F Block	1479(1472)	153	0.47	2,517,439,565.00	1,702,122.76
12	Cellular Unserved	14	22	0.00	1,842,533.00	131,609.50
14	WCS	126	24	0.00	13,638,940.00	108,245.56
15	DARS	4	2	0.00	173,234,888.00	43,308,722.00
16	800 MHz SMR	525(524)	62	0.19	96,232,060.00	183,299.16
17	LMDS	986(864)	139	12.37	578,663,029.00	586,879.34
18	220 MHz	908(693)	54	23.68	21,650,301.00	23,843.94
20	VHF Public Coast	42(26)	8	38.10	7,459,200.00	177,600.00
21	LMS	528(239)	5	45.27	3,438,294.00	6,511.92
22	PCS	347(302)	57	12.97	412,840,945.00	1,189,743.36
23	LMDS	161	90	0.00	45,064,450.00	279,903.42
24	220 MHz	225(222)	18	1.33	1,924,950.00	8,555.33
25	Closed Broadcast	115	242	0.00	57,820,350.00	502,785.65
26	929 and 931 Paging	2499(985)	81	60.58	4,122,500.00	1,649.66
27	Broadcast	1	3	0.00	172,250.00	172,250.00
28	Broadcast	2	4	0.00	1,210,000.00	605,000.00
30	39 GHz	2175	35	0.00	410,649,085.00	188,804.18
32	AM Broadcast Stations	3	5	0.00	1,520,375.00	506,791.67
33	Upper 700 MHz Guard	96	15	0.00	519,892,575.00	5,415,547.66
34	800 MHz SMR General	1053(1030)	26	2.18	319,451,810.00	303,661.42
35	PCS C&F Block	422	87	0.00	16,857,046,150.00	39,945,606.99
36	800MHz SMR Lower	2800	28	0.00	28,978,385.00	10,349.42
37	FM Broadcast	288(258)	456	10.42	147,876,075.00	513,458.59
38	Upper 700 MHz Guard	8	5	0.00	20,961,500.00	2,620,187.50
39	Public Coast & LMS	257(217)	7	0.00	1,144,755.00	4,454.30
40	Paging	15514(5323)	193	65.70	12,897,127.00	2,338.98
41	Narrowband PCS	365(317)	9	13.15	8,285,036.00	22,698.73
42	Multiple Address Sys	5104(878)	13	82.80	1,202,725.00	235.64
43	Multi-Radio Service	27	7	0.00	1,548,225.00	57,341.67
44	Lower 700 MHz band	740(484)	125	34.59	88,651,630.00	183,164.52
45	Cellular RSA	3	7	0.00	15,871,000.00	5,290,333.33
46	1670-1675 MHz Band	1	2	0.00	12,628,000.00	12,628,000.00
48	Lower & Upper Paging	10202(2832)	104	72.24	2,445,608.00	239.72
49	Lower 700 MHz Band	256(251)	56	2.00	56,815,960.00	221,937.34
50	Narrowband PCS	48	4	0.00	428,709.00	8,931.44
51	Narrowband PCS	5	2	0.00	134,250.00	26,850.00
52	Direct Broadcast Satellite	3	2	0.00	12,200,000.00	4,066,666.67
53	MVDDS	214(192)	14	10.28	118,721,835.00	554,774.93
54	Closed Broadcast	4	6	0.00	4,657,600.00	1,164,400.00
55	900 MHz SMR	55	17	0.00	4,861,020.00	88,382.18
56	24 GHz	880(7)	3	99.20	216,050.00	245.51
57	AMTS	20(10)	4	50.00	1,057,365.00	52,868.25
58	Broadband PCS	242(217)	35	10.33	2,043,230,450.00	8,443,101.03
59	Multiple Address Systems	4226(2223)	31	47.40	3,865,515.00	914.70
60	Lower 700 MHz Band	5	5	0.00	305,155.00	61,031.00
61	AMTS	10	7	0.00	7,094,350.00	709,435.00
80	Blanco, Texas Broadcast	1	11	0.00	18,798,000.00	18,798,000.00
82	New Analog Television	4	11	0.00	5,025,250.00	1,256,312.50

TABLE 6

FCC Spectrum Auction Revenue, 1994 - 2005



There is disturbing evidence that, despite the considerable revenue raised by the spectrum auctions, the FCC is not maximizing revenue because it is significantly misestimating bidder valuation of bandwidth in the reserve prices it sets. As explained above, the FCC sets a reserve price for licenses or packages put to auction. In 21 of 58 auctions (36.21%) licenses have been at auction but were retained by the FCC because no bidder met the reserve price. In most cases no bid whatsoever was placed on these licenses. This phenomenon ranges from .47% of licenses in auction 11 (PCS D, E, & F Blocks) to 99.20% of licenses in auction 56 (24 GHz); it averages 11.99% of licenses over all 58 auctions. In the majority of auctions the FCC has revised reserve prices downward even on licenses for which bids were received, so it is a much more significant indicator of mispricing that so many licenses received no bids at all.

Another indication of spectrum auctions' failure to maximize revenue is the way in which bidding strategies available only to a subset of bidders can systematically reduce price. Preemptive bidding is a strategy whereby a bidder offers a price for an auction item which is sufficiently large that it deters other bidders from competing for the item. This strategy is more readily available to bidders which are more heavily capitalized. For the purposes of this paper, a preemptive bid is defined operationally as a prevailing bid of at least half the mean final bid of the auction which successfully deters further bidding. Four auctions (14, 11, 30, and 48) were analyzed for the presence and consequences of preemptive bidding. Two types of such bidding were observed. Type 1 consists of a large initial bid which deters other bidders from ever bidding on the item. Type 2 consists of a large bid in later rounds which deters other bidders from further bidding. As Table 7 illustrates, bidders using type 1 preemptive bids in auction 14 obtained items on average at only 7.30% of the mean price paid by bidders who did not use this strategy. The success of this strategy was smaller in the other four auctions, but still significant: in auction 11 type 1 preemptive bidders obtained items on average at 46.19% of the mean price paid by

TABLE 7	Auction 14 (WCS)	Auction 11 (PCS D, E, F Block)	Auction 30 (39 GHz)	Auction 48 (Lower and Upper Paging Bands)
Preemptive Type 1	0.02358610	0.13645532	0.03566729	0.00094472
Preemptive Type 2	0.02629208	-	-	-
Other Than Preemptive Type 1	0.32288502	0.29543305	0.08612346	0.00175541
Other than Preemptive	0.38155176	-	-	-

bidders who did not use the strategy, in auction 30 at 41.41%, and in auction 48 at 53.82%. In auction 14 bidders using type 2 preemptive bids obtained items on average at 6.89% of the mean price paid by bidders who did not use the strategy. The perviousness of FCC spectrum auctions to strategic behavior available to bidders better capitalized than other bidders – a function of initial capitalization asymmetries – results in depression of price in favor of those bidders and adversely affects revenue.

Affirmative Inaction: Designated Entities, Small Business, Women, and Minorities

In authorizing the FCC to conduct spectrum auctions Congress mandated that the agency use such auctions to increase economic opportunity for small businesses, women and minorities. An examination of the FCC's own auction data suggests that this mandate has been willfully ignored by the agency.

The most data is available for participation of small businesses in spectrum auctions. Of the 22,649 licenses and permits awarded by auction 1,435 have been acquired by firms meeting the small business criteria of the FCC – 6.34% of all licenses. The FCC has worked its way though an increasingly arcane set of rules regarding small business participation in spectrum auctions, none of which appear to have had a substantial effect in increasing the success of small business bidders. In auction 5 – PCS C Block – the "entrepreneur" category was embraced:

> *To qualify as an entrepreneur, bidders must have gross revenues of less than $125 million in each of the last two years and total assets of less than $500 million at the time the FCC Form 175 application was filed).*[18]

The "bidding credit" strategy also emerged:

> *Qualifying applicants in Auction No. 5 were eligible for a bidding credit on C block licenses that represents the amount by which a bidder's winning bids are discounted. The size of the bidding credit depends on the average gross revenues for the preceding three years of the bidder, as provided in 47 C.F.R. § Section 24.709 and §24.720(b).*
>
> *• A bidder with average gross revenues not exceeding $40 million for the preceding three years received a 25 percent discount on its winning bids for C.*
>
> *The definitions of very small business and small business (or a consortium of very small or small businesses; including calculation of average gross revenues) are set forth in 47 C.F.R. § 24.720(b).*

Winning bidders of C licenses should note that transfer and assignment restrictions and unjust enrichment provisions apply to winning bidders that use bidding credits and subsequently assign or transfer control of their licenses to an entity not qualifying for the same levels of bidding credits.[19]

Eighty-nine small business "entrepreneurs" acquired 493 licenses in this auction. The same rules were followed in auction 10 – the PCS C Block Reauction – in which seven small businesses acquired 18 licenses. In auction 11 – PCS D, E, and F Blocks – the entrepreneur rule was in place and the "bidding credit" strategy was modified:

Size of an F-block bidding credit depends on the annual gross revenues of the bidder and its affiliates, as averaged over the preceding three years.

** A bidder with gross annual revenues of not more than $15 million receives a 25 percent discount on its winning bids, and*

** A bidder with gross annual revenues of not more than $40 million receives a 15 percent discount on its winning bids.*[20]

Ninety-three small businesses acquired 598 licenses. In auction 14 – WCS – the "bidding credit" strategy was continued. Eight small businesses acquired 32 licenses in this auction. In auction 22 – PCS – the "bidding credit" strategy was again adopted. Forty-eight small businesses under this definition acquired 277 licenses. In auction 25 – Closed Broadcast – the "bidding credit" strategy was amended to reward new entrants:

In the "Closed" Broadcast Auction, the bidding credit depends upon the number of ownership interests in other media of mass communications that are attributable to the bidder-entity and its attributable interest-holders. (See PN DA99-1346 (pdf) for more information)

• A 35 percent bidding credit will be given to a winning bidder if it, and/or any individual or entity with an attributable interest in the winning bidder has no attributable interest in any other media of mass communications, as defined in 47 C.F.R. § 73.5008; and,

• A 25 percent bidding credit will be given to a winning bidder if it, and/or any individual or entity with an attributable interest in the winning bidder has an attributable interests in no more than three media of mass communications, as defined in 47 C.F.R. § 73.5008; and,

• No bidding credit will be given if any of the commonly owned mass media facilities would serve the same area as the proposed broadcast or secondary broadcast station, as defined in 47 C.F.R. § 73.5007, or if the winning bidder, and/or any individual or entity with an attributable interest in the winning bidder, have attributable interests in more than three mass media facilities.

> ***However, attributable interests held by a winning bidder in existing low power television, television translator or FM translator facilities will not be counted among the bidders' other mass media facilities.***[21]

Neither winner of the two licenses in this auction was a new entrant. In auctions 27 and 28 – both Broadcast – the same rule prevailed, but no new entrant did. In no other auctions does the FCC report that small businesses or new entrants acquired licenses and inconsistencies in data categories and lacuna in reporting by the FCC make it impossible to determine whether this is an artifact of the failure of small businesses to prevail or inept data reporting by the FCC. At the very least it implies that FCC ceased to care whether this information was made available to the public or not.

The extent to which any measures undertaken by the FCC under its designated entities program have ameliorated discrimination against women and minorities is virtually impossible to determine, although the FCC's own studies suggest that not much has happened. The FCC does not make easily available data on the gender and ethnicity of auction bidders; indeed, only one bidder in all the auctions is identifiably female by name – Helen Wong-Armijo. A Congressional Budget Office study, based on data provided to it by the FCC, indicates that in the Regional Narrowband, Broadband PCS C Block, Broadband PCS D, E & F Block, Specialized Mobile Radio, and Multipoint Distribution Service auctions women and minorities did not do especially well except in the PCS C Block auction. Table 8 contains the relevant data. Studies commissioned by the FCC

TABLE 8

Auction Number	Type	# of Licenses in Auction	Number of Bidders	Number (%) of Licenses Acquired by Minority-Owned Businesses	Number (%) of Licenses Acquired by Women-Owned Businesses
3	PCS Narrowband Region	130	24	6(4.00)	5(3.85)
5	PCS C Block	493	253	150(30.43)	95(19.27)
6	MDS	489	188	10(2.05)	35(2.35)
7	900 MHz SMR	1020	123	31(3.04)	19(1.86)
11	PCS D,E,F Block	1479(1472)	153	70(4.76)	50(3.40)

and reporting on spectrum auctions through 2000 are depressingly acute on the continued presence of real discrimination. In terms of auction utilization they report:

> ***Measured across all wireless auctions through 1999, minority and women applicants were less likely to win at least one license than were non-minority applicants.... Minorities and women qualified for auctions at significantly lower rates than non-minorities. The reasons for this result are not entirely clear, suggesting this is an area for future research...***[22]

One might think that historical patterns of income, credit, and entry discrimination and the FCC's collusion in their perpetuation simply never occurred to the analysts as an explanation, if another study commissioned by the FCC at the same time had not made the point directly:

> ***Minorities and women repeatedly report encountering discrimination in their efforts to obtain capital to finance their broadcast and wireless businesses, discrimination in securing advertising on their stations, and discrimination by members of their communities and members of the communications industry.... Small telecommunications businesses generally, and those owned by women***

and minorities in particular, report that the market consolidation permitted by the relaxation of the FCC's ownership rules has created nearly insurmountable obstacles to those seeking to enter, or even survive as a small player, in the broadcast industry.... Minority-owned firms report that the repeal of the former tax certificate program - which, from 1978 until its repeal in 1995, provided tax incentives to encourage firms to sell broadcast licenses to minority-owned firms - has had a severe negative impact on their ability to obtain new stations; and Interviewees believed that EEO enforcement has been uneven over the past fifty years. This reported uneven enforcement coupled with industry hiring practices has hindered the ability of minorities and women to obtain the work experience that could one day assist them to become broadcasters themselves.[23]

This is, bluntly put, a continuing national scandal about which the FCC has done little or nothing.

Conclusions

Analysis of the last ten years of FCC spectrum auctions reveals that these auctions have met neither the standards nor the expectations expressed by Congress in their authorization. They do not facilitate the development of robust markets or meet the needs of the broader public interest. Instead these auctions, as they have been conducted, appear to serve the narrow interest of dominant actors in the telecommunications industry. They have systematically resulted in market concentration and the growth of the oligopolistic market power of major actors in the telecommunications industry. They have been pervious to manipulation by tacit collusion among bidders in ways which no minor amendment of the auction process could possibility remedy. Even the often made argument that FCC spectrum auctions maximize revenue fails in the face of both FCC mispricing of licenses, reflected in the large number of licenses which fail to be auctioned because no bidder meets the reserve price, and substantial evidence that strategic behaviors like preemptive bidding can guarantee better capitalized bidders licenses at consistently lower prices than their competitors.

What has principally driven the adoption of spectrum auctions by the FCC and Congress has been ideologically-libertarian economic theory, captured in simplistic models which ignore inconvenient facts. Game theory is a powerful tool for analysis of economic behavior. However, a game-theoric model is only as good as its assumptions. Assumptions about information, bidder resources, risk-acceptance and -aversion, and the structure of bidder preference all matter, because they imply things about how the real world operates. All modeling is along a continuum between analytical tractability and empirical verisimilitude: the more mathematically tractable the model is, the less it resembles the real thing being modeled. It is for this reason that social scientists frequent evaluate and refine such models through experiments to see whether an analytically tractable model captures what really matters about the thing it models. The past ten years of FCC spectrum auctions have amounted to such an experiment, and the experiment demonstrates that the models on the basis of which Congress and the FCC were persuaded to adopt spectrum auctions fail dramatically in their prediction of real-world outcomes. When tested by the actual performance of such auctions, the chasm between the outcomes predicted by theory and the outcomes observed is immense. In sacrificing the public interest in pursuit of hypothesized market efficiencies and greater revenue we have arrived at the worst of both worlds: FCC spectrum auctions neither serve the public interest nor realize the promised economic efficiencies and revenue maximization touted by their advocates.

Appendix A: An Excursus on the History of an Idea

How spectrum auctions came about reveals a fundamental problem with the relationship between economic theory and public policy. John McMillan, one of the architects of FCC spectrum auctions, candidly exposed the problem in a 1994 journal article:

> *The story of how the spectrum auction was designed is a case study in the policy application of economic theory. The major telephone companies and the government relied on the advice of theorists. Paul Milgrom, Robert Wilson, and Charles Plott were hired by Pacific Bell, Jeremy Bulow and Barry Nalebuff by Bell Atlantic, Preston McAfee by Airtouch Communications, Robert Weber by Telephone and Data Systems, Mark Isaac by the Cellular Telecommunications Industry Association, Peter Cramton by MCI, Robert Harris and Michael Kat by Nynex, Daniel Vincent by American Personal Communications, John Ledyard and David Porter by the National Telecommunications and Information Administration and the author of this article by the Federal Communications Commission (FCC).*[1]

R.H. Coase first proposed FCC spectrum auctions in 1959.[2] However, it was not until the 1980s that the seminal theoretical work was done which shaped the current design of such auctions. The FCC working paper by Kwerel and Felker in 1985 signaled official interest in the idea, which was regarded favorably by laisse-faire advocates in the Reagan administration.[3] This chain of events occasioned the flourishing of an economic theoretical literature which applied game theoretic approaches to deduction of what were thought to be ideal allocative designs. This work in turn led not only to both the harnessing of mathematical economists to the interests of potential participants in such auctions, as McMillan describes, but also to the increasing influence of such interests on the focus of theoretical research. The interaction effects of this process can be seen in virtually every aspect of FCC spectrum auctions. The decision to adopt an open bidding procedure is predicated directly on arguments from from Paul Milgrom's 1987 article on auction theory.[4] The work of Milgrom, Robert Wilson, Preston McAfee, and John McMillan materially shaped the sequential design and stopping rules of FCC spectrum auctions.[5] The FCC's designated entities program is largely predicated on Myerson's 1981 article and a 1987 article by McAfee and McMillan.[6]

A full history of the development of the auction design is outside the scope of this paper. However, what is pertinent is that a crucial nexus was established between highly theoretical work in mathematical economics and the material interests of both the FCC and potential auction participants. This should not be unacceptable in principle, but a crucial constraint on the operationalization of theory was woefully minimized.

All economic theory is a balancing act along a continuum between representation of the real world (what is often called empirical verisimilitude) and analytical tractability. Trade-offs are made in the form of tractability assumptions which permit the mathematization of model. The farther such theoretical models retreat from assumptions which reflect realities in order to achieve something which can be tractably analyzed mathematically, the more likely it is that such theory will no longer be empirically predictive with sufficient granularity to be a useful adjunct to policy. The matter is complicated further when economic theory is harnessed to and tempered by the interests of actors who stand to directly benefit from the adoption of a particular policy. This is

precisely what has happened with the theoretical literature on the basis of which spectrum auctions were sold to Congress and upon which the current spectrum auction design is predicated.

This is not to say that all economic theory is useless nor that policy should not be significantly guided by such theory – the game-theoretic work on tacitly collusive strategies in sequential auctions is compelling when potential complications arising from empirical circumstances are taken into account. It is, however, a cautionary tale for the way in which public policy predicated on abstract economic theory can falter on the shoals of gritty reality.

Endnotes

Executive Summary

[1] U.S. Government, Congressional Budget Office, *The Budget and Economic Outlook: Fiscal Years 2001-2010* (Washington, D.C., 2000), Appendix B.

[2] Commercial Spectrum Enhancement Act, Pub. L. No. 108-494, 118 Stat. 3986, Title II (2004) (codified in various sections of Title 47 of the United States Code) ("CSEA").

[3] U.S. Government Accountability Office, Report to Congressional Committees, "Strong Support for Extending FCC's Auction Authority Exists, but Little Agreement on Other Options to Improve Efficient Use of Spectrum," December 2005, GAO-06-236.

[4] Ibid, *see also* Auctioning Spectrum Rights, Evan Kwerel & Walt Stack, FCC, Feb. 20,2001. http://wireless.fcc.gov/auctions/data/papersAndStudies/aucspec.pdf

[5] William Safire, "The Greatest Auction Ever," *New York Times*, March 16, 1995

[6] Senator Larry Pressler, "FCC/SPECTRUM/PUBLIC BROADCASTING REFORM," Congressional Record, s13312 (Senate - September 11, 1995).

[7] There are thirty-five auctions in which the difference is significant at alpha < .001, one auction in which the difference is significant at alpha < .01, and one auction in which the difference is significant at alpha < .05. In 19 auctions there was too small a sample.

[8] U.S. Government. Federal Communications Commission, "FCC Econometric Analysis of Potential Discrimination Utilization Ratios for Minority- and Women-Owned Companies in FCC Wireless Spectrum Auctions," December 5, 2000, http://www.fcc.gov/opportunity/meb_study/auction_utilization_study.txt. The study was prepared by Ernst and Young LLP for the FCC.

[9] In the Matter of Implementation of the Commercial Spectrum Enhancement Act and Modernization of the Commission's Competitive Bidding Rules and Procedures at http://www.fcc.gov/omd/pra/docs/3060-0600/3060-0600-06.doc, see also Copps statement at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-06-52A3.doc

Report

[1] The research underlying this paper was made considerably more difficult by the way in which the FCC collects and organizes auction data. Random differences in result format and variable capture – apparently a consequence of there being no authoritative decision as to how data would be collected –– are rife in the FCC's databases. Information on designated entity participation is particularly difficult to retrieve. Frankly, if the evident cause for the incoherent data capture and reporting were not incompetence, one might think the cause to be fraud. There is a fundamental need for greater rigor and consistency in FCC auction results collection and reporting without which the reliability of FCC data must be questioned.

[2] These exempted categories included non-commercial education and public broadcast stations, public safety radio services, and replacement of analog television licenses with digital television licenses.

[3] U.S. Government, Congressional Budget Office, *The Budget and Economic Outlook: Fiscal Years 2001-2010* (Washington, D.C., 2000), Appendix B.

[4] The FCC departed from this auction design in 1994 for the Interactive Video and Data Service (IVDS) auction in July 1994, using an oral outcry design instead.

[5] Auctions are predicated on the bidder with the highest private value winning. This is no guarantee that bidders with the highest social value will prevail. This tension between private and social value has been resolved in FCC spectrum auctions almost entirely in favor of private value.

[6] Note that fractions are rounded in this analysis.

[7] This analysis was not performed for auctions in which fewer than five licenses/permits were at auction or in which fewer than five bidders participated.

[8] The formula for calculating the chi-square is $S[(O - E)^2/E]$, where O is the observed frequency and E is the expected theoretical frequency.

[9] When one controls for differences in size of population in license region by a weighting for price (high bid/population), this assumption is quite literally true because each auction allocates all of the designated bandwidth and the amount of bandwidth acquired reflects market share in that bandwidth.

[10] The formula for the HHI is $S\ s_i$, where s_i is the market share of bidder i. The Theil coefficient of inequality produces similar results for the auction data tested here.

[11] Peter Cramton and Jesse A Schwartz, "Collusive Bidding in the FCC Spectrum Auctions," *Contributions to Economic Analysis & Policy* 1:1 (2002).

[12] Ibid.

[13] Ibid.

[14] Richard Engelbrecht-Wiggans and Charles M. Kahn, "Low Revenue Equilibria in Simultaneous Auctions," Working Paper, University of Illinois, 1999.
[15] Sandro Brusco and Guiseppe Lopomo, "Collusion Via Signalling in Simultaneous Ascending Bid Auctions with Heterogeneous Objects, With and Without Complementarities," *Review of Economic Studies* 69:2 (2002), 407-436.
[16] Viz. Robert Axelrod and William D. Hamilton, "The Evolution of Cooperation". *Science* 211 (1981), 1390–1396; Robert Axelrod, *The Evolution of Cooperation* (1984) and *The Complexity of Cooperation*. (Princeton: Princeton University Press, 1997); David Kreps, Robert Wilson, Paul Milgrom, and John Roberts, "Rational Cooperation in the Finitely Repeated Prisoners' Dilemma." *Journal of Economic Theory* 27 (1982), 245–52; and Paul Milgrom, "Axelrod's The Evolution of Cooperation." *Rand Journal of Economics* 15(1984), 30–59.
[17] Eli Noam, "Spectrum Auctions: Yesterday's Heresy, Today's Orthodoxy, Tomorrow's Anachronism," *Journal of Law and Economics* (1998).
[18] http://wireless.fcc.gov/auctions/default.htm?job=auction_factsheet&id=5.
[19] Ibid.
[20] http://wireless.fcc.gov/auctions/default.htm?job=auction_factsheet&id=11.
[21] http://wireless.fcc.gov/auctions/default.htm?job=auction_factsheet&id=25.
[22] U.S. Government,- Federal Communications Commission, "FCC Econometric Analysis of Potential Discrimination Utilization Ratios for Minority- and Women-Owned Companies in FCC Wireless Spectrum Auctions," December 5, 2000, http://www.fcc.gov/opportunity/meb_study/auction_utilization_study.txt. The study was prepared by Ernst and Young LLP for the FCC.
[23] U.S. Government,- Federal Communications Commission, "Historical Study of Market Entry Barriers, Discrimination and Changes in Broadcast and Wireless Licensing: 1950 60 Present," December 2000, http://www.fcc.gov/opportunity/meb_study/historical_study.txt. The report was prepared for the FCC by the Ivy Planning Group LLC.

Appendix

[1] John McMillan, "Selling Spectrum Rights," *Journal of Economic Perspectives* (1994).
[2] R.H. Coase, "The Federal Communications Commission," *Journal of Law and Economics* 2 (1959).
[3] Evan R. Kwerel and Alex Felker, "Using Auctions to Select FCC Licenses," OPP Working Paper No. 16, FCC, May 1985.
[4] Paul Milgrom, "Auction Theory," in Truman Bewley, ed., *Advances in Economic Theory* (Cambridge: Cambridge University Press, 1987).
[5] McMillan, op. cit.
[6] R. Myerson, "Optimal Auction Design," *Mathematics of Operations Research* 6 (1981); R. Preston McAfee and John McMillan, "Auctions and Bidding," *Journal of Economic Literature* 25 (1987).

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