Federal Communications Commission
Spectrum Policy Task Force

Report of the Spectrum Rights and Responsibilities Working Group

November 15.2002

Spectrum Rights and Responsibilities Working Croup

David Furth, Chair
Diane Conley
Lloyd Coward
Howard Griboff
Karl Kensinger
David Krech
Evan Kwerel
Anhur Lechtinan
Sara Mechanic
Chris Murphy
Paul Murray
Bruce Roinano
Priya Shrinivasan
Martha Stancill
Scot Stone
Doug Webbink
John Williams
Lori Kalani (intern)

Disclaimer

The findings and recommendations contained in this Report are those of the Spectrum Rights and Responsibilities Working Group members, and do not necessarily reflect the views of the Commission, Commission management, or the Spectrum Policy Task Force.

Table of Contents

I. Introduction 1
II Spectrum Usage Models arid Incentives for Efficient Use of Spectrum 2
A. Spectrum Usage Models: Advantages and Disadvantages 2
1. "Command-and-Control" Model 3
2. "Exclusive Use" Model 6
3. "Spectrum Commons" Model 8
B. Application of the Three Models: The Story So Far 10
C. Looking Ahead: Applying Spectrum Use Models to the Future 14
1. "One Size Does Nut Fit All" 14
2. Greater Regulatory Flexibility 16
3. Balancing Exclusive Use and Commons Models 17
a) Factors favoring exclusive use inodel 17
b) Factors favoring coininons model 19
4. Limited Use of Command-and-Control 20
III. Defining Specific Rights and Obligations Within Spectrum Usage Regimes: Existing and Optimal Approaches 21
A. Flexibility 21
B. Regulatory Certainty 24
C. Interference Standards 26
D. Secondary Market Arrangements and Commission-Granted Easements 29
E License Terms and Term Limits on Rules 33
IV Other Considerations 35
A. International Considerations 36
B. Public Safely 3x
C. Spectrum Allocated for Government Use (or Shared with Non-Governmental Uses) 40
D. Broadcast Services 42
E. Rural vs. Urban Areas 44
V Transition 46
A. General Transition Considerations 48
B. Available Transition Mechanism 49
1. Expanded rights "overlay" licenses combined with inandatory relocation of incumbents 50
2. Expanded rights "overlay" licenses with grandfathering of incumbents 50
3. Expanded rights "overlay" licenses combined with voluntary band clearing/restructuring incentives for incuinbents 50
4. Expanded rights granted to incumbent licensees under existing licenses 51
C. Factors Affecting the Choice of Transition Mechanism 51

Acknowledgements
Appendix I

I. Introduction

One of the missions of the Spectrum Policy Task Force has been to examine the types of legal rights and responsibilities the FCC assigns to licensees and other users of the spectrum it manages, and to identify alternative approaches to the definition of such rights and responsibiliticr tliat inight better promote the most efficient and productive use of this spectruin. In order to acquire a fuller understanding of the issues involved, and the consequences of various approaches to defining spectrum usage rights and responsibilities, the Task Force created a Spectrum Rights and Responsibilities Working Group, which undertook several inquiries[1]

First, the Working Group examined the comments filed in response to the Public Notice issued by the **Task** Force on June 6, 2002.[2] Second, the Spectrum Policy Task Force held a Public Workshop on Spectrum Rights and Responsibilities on August 9, 2002, in which attorneys, economists, engineers, and other experts drawn from various segments of tlie telecommunications industry and tlie academic community participared.[3] Panelists provided input regarding a number of topics, including theoretical spectrum rights iiiodels and their application to the practical realities of spectrum inanagement; the advantages and disadvantages of various licensed and unlicensed models; optimal approaches to defining technical requirements; issues particular to certain services and environments, including public safety and rural areas; and mechanisms for tiansitioning from current spectruni usage regimes to more efficient and beneficial systems. Third, the Working Group analyzed certain frequency hands in different parts of the spectruiii and different types of services that it found to he representative of the Commission's past practices with respect to establishing usage rights. The group used these analyses to: (1) understand in what circumstances arid to what extent the Commission's current rules are expressions of particular regulatory iiiodels; and (2) examine how the use of these models has either promoted or deterred spectruin efficiency and the development of new technologies and services. Fourth, the Working Group reviewed numerous articles written by a variety of experts to gain further insight into how the Cominission inight best define spectrum rights and obligations in the future to promote the most productive use of tlie radiofrequencies it manages.[4]

---

[1] The findings and recommendations contained in this Report are those of the Spectrum Rights and Responsibilities Working Group members, and do not necessarily reflect the views of the Commission, Commission management, or the Spectrum Policy Task Force.

[2] The Spectrum Policy Task Force sought comment on issues related to the Commission's spectrum policies. *See* "Spectrum Policy Task Force Seeks Public Comment on Issues Related to Commission's Spectrum Policies," ET Docket No. 02-135, *Public Notice* (DA 02-1311) (rel. June 6, 2002). The Commission received approximately 200 comments and reply comments.

[3] The Public Workshop convened on Spectrum Rights and Responsibilities (*Public Workshop on Spectrum Rights and Responsibilities*) was held on August 9, 2002. *See* "Spectrum Policy Task Force Announces Panelists for the August 9th Public Workshop on Spectrum Rights and Responsibilities," *Public Notice* (DA 02-1892) (rel. August 2, 2002). A transcript of the Public Workshop can be found at <http://www.fcc.gov/sptf/files/0809fcc.pdf>

[4] A bibliography (with summaries) is attached as Appendix I.

This overview summarizes the Workiiig Group's tindings. conclusions, and recommendations with respect to spectrum rights and responsibilities, based on the input received from the coiiinienters and participants in the Public Workshop on Spectrum Rights and Responsibilities.

11. Spectrum Usage Models and Incentives for Efficient Use of Spectrum

A. Spectrum Usage Models: Advantages and Disadvantages

The Workiiig Group examined the Commission's spectruin policies and rules defining spectruin usage rights in relation to three general inodels:

(1) "Command-and-control" inodel The traditional process of specrruin inanageinent in the United States, currently used for most spectrum within the Commission's jurisdiction, allocates and assigns frequencies to limited categories of spectruin users for specific government-defined uses. Service rules for the band specify eligibility and service restrictions, power limits, build-out requirements, and other rules.

(2) "Exclusive use" model **A** licensing model in which a licensee has exclusive and transferable rights to the use of specified spectrum within a defined geographic area, with flexible use rights that are governed primarily by technical rules to protect spectrum users against interference. Under this model, exclusive rights resemble property rights in spcctruin, but this inodel does nor imply or require creation of "full" private property rights in spectruin.

(3) "Commons" or "open access" model. Allows unlimited numbers of uiilicensed users to sliare frequencies, with usage rights that are governed by technical standards or etiquettes hut with no right to protection froin interference. Spectrum is available to all users that comply with established technical "etiquettes" or standards that set power limits and other criteria for operation of unlicensed devices to mitigate potential interference.

Coininenters and panicipants in the Public Workshop gave significant input with respect to each of the inodels. Most parties provided little guidance regarding specific bands in which these models should be applied, but rather, coininented at length on the general advantages and disadvantages of each inodel. There **was** not a consensus on which iiiodel is best under all conditions. though many coininenters observed that the status quo – which primarily relies on tlie "coiiiiiiaiid-and-control" model – significantly limits cfficicncy in inany cases.

Each of these models represents an ideal. In reality, the models involve different levels of regulatory involvement, with the command-and-control inodel being the most proscriptive. **All** licensees can and should benefit froin the lessons of the three basic models. In other words. for any given licensee, the Commission couldadopt greater

interference protection consistent with the command-and-control inodel, enhanced flexibility consistent with the exclusive-use model, or enhanced access to spectrum consistent with the commons model.

I. "Command-and-Control" Model

The traditional process of spectrum inanagement in the United States is referred to by some as the "command-and-control" tnodel because of the strict control and oversight exercised by the government. The corninansand-control model process involves four steps: allocation, adoption of service rules, assignment, and enforcement.[5] In the allocation process, the Coinmission decides what types of uses it will permit in particular spectrum bands. Next, the Commission establishes service rules that specify the power limits, build-out requirements, and other rules for the service allocated in this band. The Commission then assigns licenses for use of the spectrum to specific parties through mechanisms such as first-coine-first-served licensing, lotteries, comparative hearings, or auctions. Finally. the Commission enforces its allocations, service rules, and assignments against the licensees and other users of the spectruin.

The Commission's task in applying the coiiiiiiand-and-control inodel is enormous. The Commission must continually decide and revisit difficult technical questions concerning spectrum allocation, geographical coverage. system configuration, channelization, power flux density, coding, out-of-band emissions, and innumerable other technical criteria at discrete points in time." For allocations that cross International borders, tlic Commission must work with the National Telecommunications and Information Administration **(NTIA).** the Department of State, and the International Telecommunication Union (ITU) to coordinate domestic coininercial proposals with government and multi-national uses. Meanwhile, rapid technological advances, changing consumer demands, aiid new market developments steadily erode the utility of spectrum-management decisions that the Commission inade years prior to deployment.'

Most commenters and worksliop participants stressed the costs imposed by the command-and-control approach on licensees and the public, and argued that these costs could he substantially reduced by adopting a more market-oriented approach. One of these commenters characterized the traditional policy as "ultra-conservative," arguing that the Commission gives too much weight to the potential for interference, which burdens new entrants with restrictions and delays the introduction of new technology and competition to the public.[8] Some questioned the Commission's ability lo allocate resources efficiently even under the best of circumstances.[9] In addition, various patties argued that. while the Commission lias a process to consider transfers and assignments,

[5] *See, e.g.*, Lawrence J. White, 9-Fall Media L. & Pol'y 19, 23-24 (2000).

[6] *See generally* Principles for Reallocation of Spectrum to Encourage the Development of Telecommunications Technologies for the New Millennium, *Policy Statement*, 14 FCC Rcd 19868 (1999) (*Spectrum Policy Statement*).

[7] *Spectrum Policy Statement*, 14 FCC Rcd at 19868-69, ¶¶ 1-5.

[8] *See* Thomas Hazlett (Hazlett) Reply Comments at 1.

[9] *See* Gerald Faulhaber and David Farber (Faulhaber and Farber) Comments at 5; *see generally* Hazlett Comments.

tlic current approach is overly burdensome and makes it difficult for spectruin to inovc to its highest-valued use. These coininenters contended that a well-functioning market for resources offers a level of efficiency that a centralized, bureaucratic approach can never match.[10]

Several commenters, liowever, argued in favor of retaining a command-and-control approach to allocation for certain services on the grounds that inore market-based alternatives, such as the exclusive use model, would undervalue or thwart the provision of some important services.[11] Advocates for public-safety organizations contended that the benefits from providing their services cannot be measured in economic term – arguing that one cannot put a price on safety or human life and that the spectrum necessary for such services should iiot be subject to market mechanisms.[12] Some private radio operators argued that they support the nation's industrial and coininercial infrastructure, and therefore they should not have to face the greater risk that would accompany a move away froin the status quo.[13] Radio astronomy advocates feared that an allocation inechanisin that does not include a significant government role will undervalue long-teriii scientific research projects that may offer significant social henefits hut also require dedicated spectruiii bands.[14] Similarly, several satellite operators argued rhat inoving to an exclusive use inodel may give too little weight to the public interest benefits of serving reiiiote and rural areas and providing an alternative cointnunications infrastructure for use in case of disasters.[15] Broadcast commenters asserted that statutory

---

[10] *See generally* Faulhaber and Farber Comments; Statements of Thomas Krattenmaker and Peter Pitsch at the *Public Workshop on Spectrum Rights and Responsibilities*

[11] *See, e.g.*, Consumer Federation of America Comments at i ("The moment spectrum is auctioned, rhc private economic interests of the license holder comes into conflict with the citizen interest. Onccthc airwaves are sold-off – "propertized" or "monetized" in current jargon – rhc new owners will decide who gets to use ir ").
and how it is used If you have enough money, you get to speak, if you do nor, you are out of luck.").

[12] *See, e.g.*, Association of Public Safety Communications Officials-International (APCO) Comments at 3, Statements of Ron Haraseth and David Warner, respectively, at the August 5, 2002 Public Workshop on Spectrum Efficiency (*Public Workshop on Spectrum Efficiency*) at 70, 73; *see also* Satellite Industry Association (SII) Comments at 18 (noting that "[s]everal features of satellite systems offer advantages for public safety, law enforcement and emergency response organizations."); Bergen County Comments at 1-5 (noting that "market oriented policies are but one" consideration for the Commission in executing its statutory public interest mandate).

[13] *See, e.g.*, Private Radio Commenters Commcnrs at 2 (many businesses are inherently dangerous, and the licensees cannot afford the risk of loss of critical communications services from a commercial provider): Aeronautical Radio, Inc. (ARINC) Comments at 2 ("Allocations will always be needed to provide for safety functions, especially where radio is the only means of communication.")

[14] *See, e.g.*, National Radio Astronomy Observatory Comments.

[15] *See, e.g.*, Boeing Comments at 8, 9-10 ("it would disserve the public interest if the Commission placed its goal of spectrum efficiency above its other equally important and statutorily mandated goals and obligations"): SIA Comments at 4 (noting that the Communications Act requires the Commission "to rnokc available, so far as possible, to all the people of the United States, a rapid, efficient, Nation-wide, and world-wide wire and radio communication service with adequate facilities at teasonahlc charges. . .") (citation omitted); Statements of Michael Fitch at the *Public Workshop of Spectrum Efficiency* at 150 ("the safety implications [of spectrum used for commercial aviation and navigation] arc veryhigh"); Mobile Satellite Venture Comments at 15 (auctioning the right to flexibly use satellite spectrum would "thwart the Commission's goals of ensuring service to rural and underserved areas and would lead to decreased spectrum efficiency and utilization").

public interest considerations and the tree over-the-air nature of broadcasting service have liinitcd applicability to market-based spectruiii licensing models.'"

In other cases. parties asserted that transaction costs associated with asseinbling the spectrum for a communications network might inake providing service prohibitively expensive. Satellite interests, for example, stated that the transaction costs of acquiring spectruin or landing rights through hundreds of seriatim rounds of competitive bidding around the globe would prevent the deployment of international satellite systems." Other parties asserted that specific rpectruin bands are needed, and losing the rights to even a few bands could make international harmonization difficult or impossible.[18] These coininenters added that an exclusively market-hased approach inight create perverse incentives to game the international regulatory processes by encouraging nations to inake disruptive "paper filings" for spectrum and orbital resources at the International Telecommunications Union."' Accordingly, some of these commenters asserted the need for government involvement in overcoining inarket failures and prohibitively high transaction costs.

Finally, soine have argued the physical properties of spectrum, combined with the peculiarities of network industries in general and wireless telecommunications in particular, inay require acertain level of "coinilland-and-control" in any spectruin model to avoid inefficient allocation."' This argument maintained that characteristics such as consumption externalities that require a critical mass before a technology becomes useful. high switching costs that tend to "lock in" consumers to existing technologies, and large economies of scale all increase the potential for market failure and thus necessitate a higher level of regulatory involvement.

---

[16] *See generally* National Association of Broadcasters/Association lor Maximum Service Television (NAB MSTV) Joint Comments; Society **of** Broadcast Engineers (SBE) Comments; Association of Public Television Stations (APTS) Comments, National Public Radio(NPR) Comments.

See, e.g., Satellite Industry Association (SIA) Comments at 5-6, 7-8; ("Sequential auctions [in foreign countries] would necessarily follow [a U.S auction for satellite spectrum] and would deter investment in satellite systems [not only] by raising both tlic cost of such systems but also hy adding an additional level of uncertainty as to the overall licensing, and thus deployment, **costs** associated with the system.").

[18] *See* Statements of David Weinrich. Stephen Blust, Stephen Gillig, and Michael Filch ai *Public Workshop on Spectrum Efficiency*; Hughes Network System (Hughes) Reply Commenrs at 14-15.

[19] *See, e.g.*, SIA Comments at 8 ("With the advent of auctions, however. other nations may try to stake their claim to prospective auction revenues by claiming slots that U S. systems need through 'paper filings' that are never actually built.").

[20] *See e.g.*, *Or* Shy, The Economics of Network Industries, Cambridge Univ. Press 1-6 (2001).

2. "Exclusive Use" Model

The "exclusive use" iiiodel, as discussed in this report, refers to a licensing inodel in which a licensee has rights that are exclusive, flexible, and transferable, and has specific responsibilities that come with this interest.[21] Under an exclusive use iiiodel in its purest form, licensees acquire an interest in a frequency hand that is similar to a fee simple interest in the spectrum. with the right granted being exclusive and perpetual. or nearly so. Few or no restrictions exist on the coinmodification otthe spectrum, which allows for secondary market trading, with the spectrum holder's rights transferring with the sale or lease. In short, an exclusive use model provides that the licensee obtains rights to do everything within its assigiied frequencies not expressly prohibited underthe license. Finally. responsibilities also accoinpany rights to the spectrum, including technical rules that establish power and our-of-band emission limits. These responsibilities are tlic flip side of rights, indicating the level of power and potential iiiterference licensees inust tolerate froin other operators, which corresponds to the rights of these other parties.

Parties who advociitcd granting exclusive rights to licensees argue that such an approach encourages investment. They indicated that business enterprises view any potential for interference as a danger, and that incumbents are deterred from investing in new technologies if they do not have exclusive rights to spectruin and do not know who might interfere with them in the future. Some economists favored the exclusive use model because it is built on the assumption that there is scarcity in the spectrum, at least at some times and soiiie places.?' They asserted that this scarcity may he the result of limited access. or an excess of spectrum use relative to capacity. They explained that the exclusive use iiiodel promotes economic efficiency because its key characteristics– clearly defined rights, exclusivity, flexibility and transferability– are necessary for efficiently allocating any scarce resource among competing uses.

Participants representing parties interested in trading spectrum rights noted that transferability of rights would be critical in order to achieve efficient use ofthe spectrum.[23] They claimed that the right to trade this resource would allow it to be inoved in its highest valued use, which would help rectify the imbalance between spectrum shortages in some areas and surpluses in others. Rural carriers make similar arguments, noting that secondary inarkets may improve spectrum efficiency and enable providers to gain access to spectrum for use in rural markets.[24]

Parties tliat opposed an exclusive use model argued that allocation based on giving exclusive interests to licensees in particular bands may not bc the most efficient

[21] The "exclusive use" model, as referenced herein, is presented as a theoretical model, as is the commons model that follows it. Their characteristics are described below. This exclusive use model is not equivalent to the many different variants of "exclusive use" licensing currently employed by the Commission in bands throughout the spectrum.

[22] *See, e.g.*, Faulhaber and Farber Comments; Hazlett Comments.

[23] *See* Statements of Brent Wilkins at the *Public Workshop on Spectrum Efficiency*.

[24] *See, e.g.*, National Telecommunications Cooperative Association (NTCA) Comments; Rural Telecommunications Group (RTG) Comments.

policy. These parties stressed the benefits of an approach based on shared use under a coiiiinons approach, with less emphasis on a purely exclusive use inodel.[25] Other commenters ai-gued that an exclusive use approach deters innovation because technology advances at least in part out of a need to inake better use of resources, and licensees with cxclusive use rights have guaranteed access Io the spectrum resource. Several even challenged the assumption of scarcity, upon which the exclusive use model is built.[26] Some commenters further opposcd any creation of a quasi-property right in spectrum, arguing that such a step would be contrary to the Communications Act, detrimental to free speech. and a threat to economic competitiveness in communications markets.[27]

Finally. some parties raised concerns about inarket failure that could accompany a strict application of an exclusive use model. Some feared that such a model might encourage commercial hoarding of spectrum rights that would exclude innovative. nom profit, public-service or other uses of the spcctrum that benefit society as a whole. Also, they asserted that spectrum users who require immediate, **but** infrequent access to speciruni, such as public safety agencies, iiiight be unable or unwilling to pay for commercially available services that could provide the same level of reliability in times of peak demand that their current services offer.[28] In addition, they were concerned that spectrum users that require simultaneous operation over global geographic areas, such as satellite service providers, might iiot obtain internationally liannonized spectrum due Io holdout by individual spectrum owners.[29] Additionally, they observed that spectrum users that require the simultaneous use of large segments of spectruin, such as ultra wideband (UWB), or the short-tenn use of portions of a wide range of spectrum, such as software-defined radio (SDR), inight never overcome the transaction costs necessary to gain access to spectrum to operate.[30] They argue that SDR and similar technologies shrink the "frequency/time/space dimension that a user must occupy exclusively in order to communicate without interference," which in turn creates units "so small as to inake ihe transaction costs involved in negotiating allocation of exclusive property rights to them prohihitive."[31]

---

[25] *See, e.g.,* David Reed (Reed) Comments; Jon Peha (Peha) Comments; Statements of Preston Marshall at the *Public Workshop on Spectrum Efficiency.*

[26] *See, e.g.*, Werbach Comments; Reed Comments.

[27] *See, e.g.*, New America Foundation Reply Comments.

[28] *See, e.g.,* Bergen County Comments at 3 (noting "there are a range of national policy objectives, such as public safety, that simply cannot be accomplished through a market direction" and adding thatmany of these objectives "will not be achieved by awaiting a market solution"); Society of Broadcast Engineers Comments at 5 ("SBE is at a loss to understand how a blanket market-driven allocations policy can do anything but cripple [Broadcast Auxiliary Service] use during emergencies").

[29] *See, e.g.,* Statements of David Weinrich, Stephen Blust, Stephen Gillig, and Michael Fitch at *Public Workshop on Spectrum Efficiency.*

[30] *See, e.g.,* XtremeSpectrum at 5 (supporting a non-exclusive "regulatory scheme that welcomes low-power, non-interfering devices in spectrum already allocated for other purposes").

[31] *See, e.g.*, Benkler, Yochai, "Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment," Harvard Journal of Law and Technology, Vol. 11 (1998), at 322.

3. "Spectrum Commons" Model

In a spectrum commons tnodel, spectrum is available to all users that comply with established technical "etiquettes" or standards that set power limits and other criteria for operation of unlicensed devices to mitigate potential intcrfcrence. Usage rights are llenible. with minimal or no restrictions placed on the types of use of the spectrum **As** is tlic case under the regulatory regiine currently governing unlicensed Part 15 spectruin, there are no licenses" and the primary allocation method for using the spectruin is akin to "firct come, first served."

Supporters **of** the coiiiinons model argued that this approach leads tu greater technological innovation and spectral efticiency than exclusive access: because no spectrum is exclusively held, spcctrum commons users have incentives to create spectrally efficient frequency-hoppiiig technologies, whereas licensed spectruin typically sits idle when the license-holder is iiot transmitting[33] Commons supporters also stressed that this model precludes warehousing of spectrum, which can create artificial scarcity aiid is a potential disadvantage of an exclusive use model. Furthermore, proponents of an open, commons approach claimed that spectrum scarcity might actually he reduced under such a regime because of tlic efticiency enhancing possibilities of new technologies (e.g., ad hoc networks) and the fundamentally different spectrum demands of architectures such as mesh networks?'

Although there is some indication that a commons regiine inay not attract the same level of investment as an exclusive rights system, proponeiits also argued that the need for long-tertii capital investments in networks is reduced with this model because the innovation cycle is faster.[35] In addition, attracting major amounts of financing niay be less of an issue for systems such as mesh networks[36] because capital costs are distributed among users (through smart ieceivers, for exainple) rather than being concentrated at central points of transmission as in traditional architectures. However, various parties noted that industries that do require large lixed investments might have trouble attracting capital or be hesitant to invest further because of thc lack of guarantees against future interference.[37]

Parties that opposcd a spectruiii commons model, however, argued that some ot the supposed incentives for innovation do not work and that significant disadvantages

---

[32] There is, however, some process for equipment certification or approval.

[33] *See, e.g.*, Kevin Werbach (Werbach) Comments at 7 ("In a spectrum commons, every user has incentives to use spectrum wisely and intelligently, because it has no guarantee of protection against competing uses").

[34] *See* Werbach Comments at 4; Benkler, Yochai (2002) "Some Economics of Wireless Communications," 15 Harvard Journal of Law and Technology, forthcoming 2002-3, at 19.

[35] *See, e.g.*, David Reed (Reed) Comments.

[36] Mesh networks are communications architectures in which each node is connected to every other node. They operate in contrast to ring networks in which every node is part of a closed loop, or point-to-multipoint networks, which rely on key transition points.

[37] *See, e.g.*, Cellular Telecommunications & Internet Association (CTIA) Comments; Cingular Wireless LLC (Cingular) Comments; Sprint Corporation (Sprint) Comments.

also accompany use of this **model,** including: overuse, with resulting interference; service limitations due to low-power requirements and a rising noise floor; and underinvestment due to these overuse and service limitations.[38] These parties argued that a commons approach would result in a spectruni shortage.[39] They asserted that while the "tragedy of the commons"[40] could be ameliorated through rules on power levels, modulation, back-off schemes, and other approaches," it **would** remain to the extent there is too little spectrum relative to the coininunications deinanded at a given time and place."[41] Commenters also expressed concern that a "pure" commons model could lead to an unintelligible cacophony of mutually interfering signals. Without some type of government-imposed restrictions on the use of spectruiii coiniiions, commenters acknowledged that "a poorly designed system. although economically inore feasible for some. would only lend to undue hardship[]" for other spectrum users.[43] Some economists also argued that niany of the benefits of a coiniiions inodel could he achieved via private owners who allocate their spectrum for such purposes."[44]

Other commenters argued that unlicensed spectruni should not he seen as a replacement for licensed spectrum, hut akin to a public park, free for anyone to use."[45] Under this approach, the Commission would use market-based inechanisins to sell exclusive use licenses. but also preserve soiiie spectrum as an unlicensed spectruni coiiiiiioiis for new or emerging technologies. Many corninenters supporting this balanced approach also supported the allocation of additional unlicensed spectrum.[46] Other parties support inaiiitaiiiing a licensed regime with the right of non-interfering technologies

---

[38] *See, e.g.*, GPS Industry Council Comments at 3 ("The primary role of the FCC should be as steward of the nation's radiofrequency spectrum to ensure its availability for the most important and beneficial uses.").

[39] *See, e.g.*, Station Resource Group Comments at 4 ("The more speedily the Commission moves to making the spectrum a Commons, though, with all the policy shifts this implies, the more rapidly we will evolve from the current artificial scarcity construct to real scarcity. For the most part, the market is the most practical solution to a shake-out in the best interest of the public.").

[40] The tragedy of the commons occurs when too many parties have the right to use a resource, such that the resource is overused.

[41] *See, e.g.*, Jon Peha (Peha) Comments at 6; Reed Comments.

[42] *See, e.g.*, Faulhaber and Farber Comments; Statement of Peter Pitsch at the *Public Workshop on Spectrum Rights and Responsibilities.*

[43] *See* Part-15.ORG Comments at 8.

[44] *See, e.g.*, Hazlett Comments at 1-2; Faulhaber and Farber Comments.

[45] *See, e.g.*, Hazlett Comments; Faulhaber and Farber Comments.

[46] *See, e.g.*, New America Foundation et al. Reply Comments (asserting that over 20 commenters explicitly support additional unlicensed spectrum and only a handful actively oppose it); Consumer Electronics Association Reply Comments; Cisco Comments (advocating setting aside additional unlicensed spectrum to promote innovation in creating broadband devices, such as wireless LANs); Cingular Comments at 50-51 (supporting additional spectrum for unlicensed devices in unlicensed bands only, asserting that spectrum overlays in licensed bands cause too much interference); Citizens Media Corp/Allston-Brighton Free Radio Comments at 14 (asserting that spectral efficiency is contingent upon whether technical innovation is allowed to flourish through an increase in the amount of unlicensed spectrum or use of "holes" or underdeveloped areas in currently occupied areas of the spectrum); ShreveNet Comments at 2 (asserting that more license-exempt spectrum should be set aside for rapid expansion of wireless Internet).

(such as spread spectrum. or UWB devices) tu operate within the same band. rather than allocating separate unlicensed spectrum.[47]

B. Application of the Three Models: The Story So Far

In most hands. the Commission has historically used variations of the traditional coininand-and-control approach io defining rights, in which spectrum is allocated and assigned for specific uses that are limited, often very narrowly, by regulation. More recently, the Cominission has developed rules for certaiii bands tliat approximate the exclusive rights model, and rules for other bands that approximate the commons model, hut it has not applied either model tu significant portions of the spectrum, and has not used either model in a pure form.

The command-and-control approach has taken different forms over time. In inany cases the Commission has arrived at a regulatory structure through an ad hoc process of accretion over the years, while in other cases it has used a less ad hoc process and has adopted an overall plan for all services in a band at the same tiine. Moreover, some usage regimes that have command-and-control features liave allowed for considerably more usage tlexibility than others. And, many licensing regimes involve "exclusive use" licenses of a inore restricted forni than the exclusive use model involving flexible usage rights discussed in Section **II.A** above.

For example, in the 902-928 MHz band, a block of spectruni in which a number of licensed services as well as unlicensed users operate, the Commission has made a series of specific regulatory decisions over time that has resulted in a complex hierarchy of users subject io significant restrictions.[48] Thus, Federal Govemineni radiolocation systems haw priinary rights in the band. Nexr in order of priority are Industrial, Scientific, and Medical (ISM) devices, and Federal Government fixed and mobile and Location and Monitoring Systcins (LMS) are secondary to these uses. Licensed amateur radio operations and unlicensed Part 15 operations are secondary to all other uses ofthe band.

The 27.5-30.0 GHz band is another example of command-and-control regulation of a specitic hand, though in this instance, the Commission adopted an overall plan for all services in tlic band at the same tiine. In the 1990s, the Commission concluded that this band, then occupied by lixed point-lo-point inicrowave service, was underutililized, and therefore adopted a band segmentation plan that provided for use of the band by Local Multipoint Distribution Service (LMDS), a terrestrial service, and certain designated satellite uplinks and leeder links. Co-frequency sharing between services or systems was allowed in hand segments where the Coinmission and parties concluded that it was

---

[47] *See, e.g.*, XtremeSpectrum Comments at 5, 10 (advocating that certain shared spectrum technologies such as ultra-wideband, are low-power, non-interfering devices that can operate efficiently in spectrum already allocated lor other purposes).

[48] *See generally* 47 **C.F.R.** Part 15 – Radio Frequency Devices; Pan 18 – Industrial, Scientific, and Medical Equipment; Part 90, Subpart M – Intelligent Transportation Systems Radio Service; Part 97 – Amateur Radio Service.

technically feasible. For the remaining parts of the band the Coiiiinission created primary and secondary usage rights among the services.'"

From the Commission's experience with coininand–and-control regulation, it is apparent that overregulation can deter both efficiency and innovation. The highly regulated nature of certain services has tended to discourage technological change because the means of providing permissible services are narrowly defined in terms of current or ouldated techiiology. Moreover, in cases where licensees are limited in what services they arc permitted to offer, they have no incentive to seck out a higher valued use for the spectrum.

One example of restrictive regulations having such effects niay be found in the 12.75-13.25 GHz band, which **is** shared by Broadcast Auxiliary Services (BAS), Cable Antenna Relay Service **(CARS),** Fixed Microwave, Geo-Stationary Orbit (GSO), and Non-Geostationary Orbit (NGSO) Fixed Satellite Service (FSS). The Commission's rules have not permitted BAS operators to use digital modulation techniques,'" even though the broadcasting stations they serve are required to convert Lo digital television, thus complicating tlie transition to DTV and precluding other efficiencies. Other rules limit the use of the frequencies; for example, CARS licensees are permitted to transmit only video signals (not voice or data). In addition, some of the required procedures for liiiiiting potential interference between users of the hand reduce the efficiency gains that could be obtained from the use of technologically advanced real time frequency coordination devices Limitations on licensee eligibility for BAS aiid CARS licenses have also contributed to the inhibition of innovation in these fixed services. Only recently has tlie Commission expanded eligibility for CARS licenses to include previously noli-eligible multichannel ideo programming distributors such as private cable operators.[51]

The Commission has begun to move away Iroin command-and-control to more tlrxihle spectruni policies iii recent years. In addition, the Commission has amended a variety of service rules to increase the llexibility of existing services. Among the many examples that could be cited are the Paging and Radiotelephone Services rules. Early technological aiid regulatory restrictions regarding the provision *of* onoway paging service have been eliminated and paging licensees are free to develop and implement new

---

[49] *See, e.g.*, Rulemaking To Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, To Reallocate the 29.5-30.0 GHz Frequency Band, To Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services; Petitions for Reconsideration of the Denial of Applications for Waiver of the Commission's Common Carrier Point-to-Point Microwave Radio Service Rules, Suite 12 Group Petition for Pioneer Preference, CC Docket No. 92-297, *Second Report and Order, Order on Reconsideration, and Fifth Notice of Proposed Rulemaking*, 12 FCC Rcd 12545 (1997); *Third Report and Order*, 12 FCC Rcd 22310 (1997); *Third Order on Reconsideration*, 13 FCC Rcd 4856 (1998); 47 C.F.R. §§ 101.103, 101.1005.

[50] In the Matter of Revisions to Broadcast Auxiliary Service Rules in Part 74 and Conforming Technical Rules for Broadcast Auxiliary Service, Cable Television Relay Service and Fixed Services in Parts 74, 78 and 101 of the Commission's Rules, ET Docket 01-75, *Report and Order* (FCC 02-298 (rel. Nov. 13, 2002).

[51] *See* Amendment of Eligibility Requirements in Part 78 Regarding 12 GHz Cable Television Relay Service, CS Docket No. 99-250, *Report and Order*, 17 FCC Rcd 9930 (2002).

technologies and uses, including one-way messaging, two-way inessaging, niobile data, and fixed wireless services?' The Coininission has also amended certain Pan 15 rules several times in the last fifteen years to accommodate technological developments in spread spectrum technology.[53] Nonetheless, broad applications of flexible rights policies have been adopted for only relatively limited portions of the spectrum,

To the extent that tlie Coiiiiiiission has adopted a tlexible exclusive use approach to spectrum licensing, there is general consensus that the Commission's most successful application of this approach to date in terms of deployment of service has been broadband Personal Communications service (PCS), operating in the 18501910 MHz and 1930-1990 MHz baiids. The PCS rules follow the exclusive use model quite closely: the Commission granted PCS licensees rights to large blocks of spectrum and allowed substantial flexibility in terms of technology and usage rights, suhject only to interference parameters to protect neighboring geographic ureas and adjacent spectrum blocks. There are no othcr users of the band other than fixed microwave incumbents, which are suhject to mandatory relocation requirements. Howevcr. unlike the "pure" exclusive use model, the PCS rules do not allow for unrestricted llexibility of usc, because the allocution precludes use of this speclruiii *for* broadcasting.

While the rapid proliferation ofwireless services in the PCS band is well documented, the Commission's application of a tlexible exclusive use model in some other bands (e.g., Wireless Communications Service (WCS)) has not been equally successful. Some panies have claimed that the rules governing these services are "excessively" tlexihlc and that. as a result, manufacturers have not known what sort of equipment to build.[54] Nonetheless, this does not necessarily mean that the slower development of certaiii services accorded flexible rights is attributable to the flexible iiature of the usage rights awarded by tlie Commission. In some instances, prior allocation and licensing decisions by the Commission have resulted in adjacent spectrum bands being used by dissimilar services with different spectrum usage characteristics, which in turn has created interference issues that impose practical constraints on liceiisees even though their licenses give them nominal flexibility. In other instances, spectrum iise has been liinitcd due to lack of market demand for service. However, even in such instances, the flexibility provided to licensees allows for iiiore productive future spectrum use when technology and inarket conditions improve, without the need for additioiial regulatory intervention.

The Commission has also applied rules to several spectrutn bands that resemble the coiiiiiions model. The 2.4 GHz band (2402-2450 MHz), for example, is used on an open access, unlicensed basis by thousands of unlicensed consumer and industrial devices. including cordless phones, microwave ovens, and wireless LANs such as those

[52] *See generally* 47 C.F.R. Part 22, Subpart E - Paging and Radiotelephone Service.
[53] *See, e.g.*, Amendment of Part 15 of the Commission's Rules Regarding Spread Spectrum Devices. ET Docket No. 99-231, *Second Report and Order*, 17 FCC Rcd 10755 (2002).
[54] *See, e.g.*, Motorola Comments at 9; Nokia Inc. (Nokia) Comments at 2.

using 802.11h and Bluetooth technology.[55] The proliferation of Wi-Fi and similar technologies was iiot anticipated when the Commission's rules for unlicensed device5 were established, but the open access and technical flexibility afforded by these rules (the primary constraint being the limitation of Part 15 devices to very low power) has allowed significant market-driven innovation. The popularity of the tinlicensed 2.4 GHz band makes it clear that there is demand for a commons-type usage model for some spectrum, and that this iiiodel can work tor several different sorts of services. The parallel to the "pure" coiiiiiioiis model is not perfect, however, hccause the typcs of equipment used must be registered and operate under certain rules such as those regarding primary use rights and equipment standards.

Moreover. not all tinlicensed bands have been as successful as 2.4 GHz. In the unlicensed PCS hand, for example, rhcre has been very little development of uiilicensed technologies, in large part because of the difficulty of establishing an effective mechanism to pay Ior the relocation of licensed incumbents in the band. The FCC established UTAM (Unlicensed **PCS** Ad Hoc **Committee** fur **2** GHz Microwave Transition and Management) to enable the transition froin use by incumbent fixed microwave licensees in the band to unlicensed use. The industry inust mllect money from manufacturers of unlicensed devices Io coinpensate incumbent fixed inicrowave liceiisees Ior their relocation. tinlicensed **PCS** products must only operate at UTAM-approved customer locations until incumbents have moved out of 1910-1930 MHz. If a product moves away froin its coordinated location it may not be reactivated, until UTAM verifies coordination at the new location.[56] UTAM assesses a fee on each unlicensed PCS product and directs the money toward tlie incumbent relocation effort ($20 in 2001). The economic noii-viability of this Compensation niechanisin plus the lack of development of equipment for use iii the unlicensed band have combined to inhibit development of a narrowband PCS service.

An examination of the flexible cxclusive use and coiiiinons models as they have been applied to date suggests that each inodel has Icd to different types of technical and economic efficiencies. In broadband PCS, for example, licensees have developed centrally managed wireless networks that cover large geographic areas and accoinniodate large numbers of mobile customers. The licensing of multiple users has also led to significant competitive benefits in tlie CMRS market. Parties that have noted the success of PCS disagree about what has driven the innovations that we have seen in that service; some think they have been driven by investments in exclusive use, while others said that they had developed because ofcoiiipetition. It seems likely that in fact both factors liave played an important role in the development of PCS. In any event, it does not appear that flexible exclusive use inodels have deterred the development of technologies and service in this instance. Although some commenters argue that exclusive use will not lead to technical innovations such as Wi-Fi, the **PCS** rules do not preclude licensees froin developing low power Wi-Fi networks **if** they choose to. The faci that PCS licensees have not done so to date is likely duc to the fact that (1) the **PCS** rules provide for

[55] *See generally* 47 C.F.R. Part 15 – Frequency Devices; 47 C.F.R. Part 18 – Industrial, Scientific, and Medical Equipment.
[56] *See* 47 C.F.R. § 15.307.

flexibility aiid interference protection that enables licensees to develop higher-power system architectures. and (2) licensees face a higher opportunity cost with respect to their spectrum that makes such archilectures a higher valued use.

In the Part 15 bands, whcrc there are strict power limits and no interference protection, the opportunity cost of spectrum is reduced to a very low amount approaching zero,[57] which forces spectrum users to channel their investment exclusively into developing robust low power technology that can function in this environment and continue to function as the environment grows iiiore congested. The initial technologics that evolved in these bands were low power devices such as cordless phones and garage door openers. More recently. the Part 15 bands have been host to the emergence of "smart" low power devices that can support more sophisticated applications, including peer-to-peer networking. This lias resulted in a significant surge of economic investment in these bands. However. the commons model may not offer sufficient certainty or reliability for other types of spectrum uses. For example. services requiring large upfront capital investments or users promising a certain standard of service to paid subscribers niay not wish to take the risk of not knowing exactly where, when, and next to whom on the spectrum they can operate. Therefore. it is unlikely that a uniform approach to spectrum management can meet the very different needs of all spectrum users.

C. Looking Ahead: Applying Spectrum Use Models to the Future

I. "One *Sire* Doer Not Fit All"

The Working Group looked ai the question of which *of* the abovedescribed spectrum iise inodels the Commission should use in the future and what the appropriate mix inight be. While the Commission's experience with existing bands provides some important lessons about the costs and benefits of various niodels that have been applied, it would not be reasonable to conclude froin this experience that there is one particular regulatory model that should be applied uniformly to all bands or all services. It is also notable that. with few exceptions. participants in the Public Workshop agreed with tlie principle that in spcctrum policy, "one size does iiot fit all."[58] Thus, while there was *a* split among coininenters and panelists who advocated an exclusive use regime and those who advocated a commons regime, most coinmenters and panelists appeared to support the proposition that there is a place in tlic Corninisaion's spectrum policy for both models. Some also asserted tliat the two can be complementary, and that grants of

[57] The opportunity cost for using Part 15 spectrum is not actually zero because, although there is no interference protection and no limit on entry, any user can choose to use some part or all of a particular band for many different uses. Thus, for example, an individual user of Part 15 devices may not be limited in the number of Wi-Fi devices he or she may install in his/her home, but this individual may find that other devices operating on the same band (*e.g.*, portable phones) may not function properly. The opportunity cost, while small, of using the WiFi devices is the inability to use a portable phone, even though users of the same frequencies a block away have no impact on the individual.

[58] *See, e.g.*, Statements of David Siddall and Michael Kurtis, respectively, at the *Public Workshop on Spectrum Rights and Responsibilities* at 119, 169; Motorola Comments at 8; Information Technology Industry Council Comments at 3.

exclusive primary rights need not constrain the development of innovative unlicensed technologies.

Commenters suggested that the FCC should seek to find a balance between a coiiiinons inodel, which would allow for unlicensed innovation and enable ad hoc open networks systems, and an exclusive use tnodel, which would give licensees sufficient predictability to stimulate long-term capital investments. Commenters also urged the Commission to consider variations and gradations of each tnodel. For example, a number of commenters suggested that granting tlexible exclusive use rights to spectrum users did not preclude tlie Commission from imposing some regulatory limitations on use. eiialogous to zoning restrictions that are placed on property owners by local governments. Any service not included in the rights granted to tlie licensee would have to be considered through a roiling-like hearing in which all interested parties could comment. Such a model would in fact be a type of limited exclusive use model. **A** different variation of a limited exclusive use tnodel would be one in which the licensee has exclusive rights to provide any service on its assigned frequencies but other users are granted easements to use those frequencies on a lion-interference basis. Certain commenters, however, were opposed to the creation of property rights, and particularly the idea of rights in fee simple, in spectrum

Participants in the Public Workshop focused a good deal of attention on how different rights models would affect emerging "smart radio" technologies, such as Software Defined Radio (SDK). They iioted that SDK will be in the marketplace soon arid that there are significant advantages Iroin using SDR.'[59] One panelist indicated that the FCC needs to come up with mechanisms for accommodating SDR and suggested that it needs to consider the practicality of not only creating inore commons but also of setting up a simultaneous exchange for trading.'[60] Another panelist observed that as communications ranges get shorter and shorter in terms of distance (for example, with developments such as W-Fi), the commons tnodel becomes inore appropriate because it entails fewer regulatoiy requirements and allows parties to focus on technical solutions for the delivery of data.

There was broad support among proponents of unlicensed spectrum use for permitting greater access to unused portions of licensed hands. even including broadcast, by smart radios on a non-interference basis. However, as indicated above. advocates of exclusive use models and incumbent licensees expressed skepticism about such an approach. It was also pointed out thai the Commission iieeds to be pragmatic in permitting frequency agile radios too niuch access to licensed band!, because licensed users should be expected to iinpleinent new technologies and therehy reduce the gaps available for frequency agile radios to use.

The issue ofcongestinn was also raised in connection with unlicensed use, and. as with many uthcr matters, thcrc was disagreement regarding whether such congestion is

[59] *See, e.g.*, Statement of Bruce Fette at the *Public Workshop on Spectrum Rights and Responsibilities* at 49, 67, 78; Hypres Comments at 4; Motorola Comments at 14-15.
[60] *See* Statement of Peter Pitsch at the *Public Workshop on Spectrum Rights and Responsibilities* at 90.

"real" or an artifact of regulation.[61] Thus, one panelist stated that the FCC needs to ensure that swaths of unlicensed spectrum do not becoine paralyzed by congestion, and one party that tiled coininents on the Public Notice indicated that all use of unlicensed spectrum should be regulated to providc clear rules regarding an access etiquette, maximum power levels, and/or duty cycle restrictions, among other trchnical considerations.[62] However, one panelist asserted that there was no real congestion in tinlicensed spectrum, only congestion caused by regulatory limits.[63]

While considerable emphasis was placed on promoting innovation through an expansion of tinlicensed uses, at least one panelist argued that licensing is of critical importance for the opposite reason, i.e., ensuring consumers that their equipment will continue to work with existing infrastructure.[64] Many agreed that this is the Commission's role. but some also indicated that this goal caii be achieved through the use of band managers.[65] Certain panelists also argued that the inarket should decide which equipment is maintained as viable, that tlie obsolescence of soine existing equipment is an indication of progress, and that the overall benefit to consumers of rival systems battling in the inarketplace outweighs the iiegative impact on those who are stranded with obsolete eqtiipiiient.""

Finally. although participants in the Public Workshop generally subscribed to the principle of "one size does not tit all," and appeared to agree that there is a place for different spectrum usage inodels, they did not supply many specifics as to how much spectrum should be designated for exclusive use relative to shared or unlicensed **uses.**

The Workiiig Group agrees with the consensus view expressed by participants in this process that "one size does nor fit all" in spectruin policy. We also believe that there is considerable room to inove froin the largely *ad hoc* approach to spectrum rights that has evolved historically to a much smaller set of basic spectruin rights inodels that can be applied more consistently and comprehensively across the radio spectrtiin as a whole.

2. Greater **Regulatory** Flexibility

In general, as the coininents suggest, we recominend that the Commission base its spectrum policy on a balance of the three basic spectruin rights iiiodels outlined in Section II.A above: an exclusive use approach, a coininons approach, and a command-and-control approach We further recommend that the Coininission fundamentally alter tlie existing balance among these models – which is dominated by legacy command-and-

---

[61] *See* Statement of Peter Pitsch at the *Public Workshop on Spectrum Rights and Responsibilities* at 42.
[62] *See* Statement of Tom Hazlett at the *Public Workshop on Spectrum Rights and Responsibilities* at 185.
[63] *See* Statement of David Reed at the *Public Workshop on Spectrum Rights and Responsibilities* at 178, 204.
[64] *See* Statement of Gee Rittenhouse at the *Public Workshop on Spectrum Rights and Responsibilities* at 69.
[65] *See, e.g.*, Statement of Tom Hazlett at the *Public Workshop on Spectrum Rights and Responsibilities* at 186.
[66] *See, e.g.*, Statement of Tom Hazlett at the *Public Workshop on Spectrum Rights and Responsibilities* at 187.

control regulation by expanding the iise of both the exclusive use and coininons models throughout tlie radio spectruiii. and limiting the use of the command-and-control iiiodel to those instances where there are compelling public policy reasons to continue using it.

Ultimately. uherever there are competing uses tor a resource – that is, wherever there is scarcity – some mechanism must exist for allocating that resource. A mechanism based on markets, such as an exclusive use model, will be most efficient in most cases. However, reasonable restrictions or rilles will he necessary to overcoine specific inarket failures. Government inay wish to employ such powers as eminent domain to acquire appropriate hands for public safety use, for example. Similarly, governinent may wish to promote the important efficiency and innovation benefits of a spectrum commons by allocating spectrum bands for shared iise, much as it allocates land to public parks. Finally. for the reasons stated above. the cniiiinand-and-control model should be reserved only for cases of significant market failure.

Thus, to the cxtent feasible, more spectruin should be identified for both licensed and unlicensed uses under flexible rules, and existing spectrum that is subject to iiiore restrictive coiiiiiiand-and-control regulation should be transitioned to these models to the greatest extent possible, as discussed below. If this approach is consistently applied to Coiiiiiiission specti-urn policy decisions, it has the potential to significantly reduce the artificial scarcity of spectruin that currently exists as a result of barriers to access. This will liave the beneficial effect of reducing the cost of obtaining exclusive spectrum rights where an exclusive use approach is used, and will also help to alleviate congestion of spectrum that is made available on a commons basis, thus mitigating (though not eliminating) tlir risk of the tragedy of the commons.

3. Balancing Exclusive Use and Commons Models

The recommendation to move towards greater reliance on exclusive use and commons models requires that the Commission also determine the appropriate balance between these two iiiodels. There are a number of variables that inay be relevant to this determination with respect to any particular hand, but the Working Group believes tliat the key factors to he considered arc (1) spectrum scarcity and (2) transaction costs associated with moving spectruiii from less efficient to more efficient use. By "spectrum scarcity," we inean the degree to which competing demands to use particular spectruiii exceed tlie supply of spectrum available. By "transaction costs;" we inean the expenditure of time and resources required for a potential spectrum user to obtain the spcctruin access rights necessary to its proposed spectruin use.

a) Factors favoring exclusive use model

In general, where spectrum scarcity is high and the transaction costs of transferring or dividing rights to the spectrum are low, these factors tend to favor application of the exclusive use model. The exclusive use inodel is appropriate because it gives the most incentives to efficiently use scarce spectruin. Where rights and responsibilities arc clearly defined and effectively enforced, the characteristics of this

model- *e.g.*, exclusivity. tlexibility. and transferability help move resources to their highest valued use When transaction costs are not so high as to impede the transfer of spectrum among alternative users, the exclusive use inodel allows inarket mechanisms to determine the iiiost efficient allocation of the scarce resource by providing a clear framework for the assignment and negotiation of spectrtiiii usage rights between spectrum users.

Where both spectrum scarcity and transaction costs are high, the exclusive use model still may be most appropriate. though this situation is less clear. The presence of high transactioii costs means that soine transfers of spectruin will not occur, aiid some valuable uses therefore will not appear in the market. However, wherever swrcity exists, there will be competing claims to the resource, and the exclusive use model is most effective at balancing these competing claims. Moreover, the greater the scarcity, the greater will be the incentive for parties to find ways to overcome these high transaction costs. In contrast, a spectrum commons would not be effective in cases of high scarcity, despite its merits at addressing high transaction costs.

These variables suggest that in the lower portion of the radio spectrum, particularly bands below 5 GHz, the Commission should focus primarily, though not exclusively, on using the exclusive use model. The propagation characteristics in this portion of the spectruin (which can support a wide variety of high- and low-power, fixed and mobile uses), coinbined with the high level of incumbent use (including governineni as well as non-government uses), result in a large number of competing demands for this spectrum relative tu the amount of spectrum available. These factors tend to weigh in favor of an exclusive use approach with tlexible rules because it provides a mechanism for spectrum users to choose among the full range of technically feasible speciruni use options based on market forces.

Application of the exclusive use inodel to these band, however, does not necessarily mean tliat all possible usage rights associated with particular spectrum must hc invested in the licensee. For example, with private property in land, it is difficult, if iiot impossible, for the governiiient to build a highway if it must negotiate with individual property owners without eminent domain powers. Similarly with spectrum, it may be prohibitively burdensome for soine potential spectrum users, *e.g.*, those with technologies like UWB that operate acro wide range of spectrum, to negotiate for spectrum access with each licensee in each band and in each geographic area that would be used. Where the prcscncc of inany spectruni license holders with exclusive use rights makes it difficult to pursue economically efficient projects because of the high transaction costs associated with negotiating spectrum access with each licensee, the potential exists to create a "tragedy of the anticommons."[67] To reduce this potential, the government iiiay create access rights for some types of spectrum uses even in spectrum that is otherwise licensed

[67] Heller, Michael (1998) "The Tragedy of tlic Anticommons Property in the Transition from Marx to Markets," 111 Harvard Law Review, 621, 622-25. 'The tragedy of the commons may occur when many parties have property-like rights tor small slivers of spectrum PO that a party wanting to use a block of spectrum iiiay find it costly aiid complicated to negotiate with many separate holders of spectrum usage rights. In such a case, the spectrum may go unused and thus become a wasted resource.

on an exclusive basis. Options for creating such access rights in an exclusive use model are presented in Section III.D below in the discussion of secondary markets and government-granted easements.

b) Factors favoring commons model

Conversely, in spectrum bands where spectrum scarcity is low and tlie transaction costs of transferring or dividing rights to the spectruin are high, these factors rend to favor application of the commons model. The commons inodel is most appropriate because it helps give access to the spectrum to users who otherwise would he deterred by these substantial negotiations costs. The coinmons approach inakes this increased access possible by replacing the tiegotiation of formal leasing and sale contracts between users and rights holders with an agreement by the user to abide by certain user protocols and etiquette. This promotes efficiency through spectrum sharing; commons users generally operate at low power for a short time in limited areas, which allows multiple users to operate on the same spectrum. The commons approach also promotes technological innovation by providing a spectrum environment iii which to develop new technologies.

Where both spectrum scarcity and transaction costs are low, the commons inodel again iiiay he the most appropriate, though this situation is less clear. Under these circumstances, the presence of low transaction costs would add to the efficiency-creating characteristics of the coininons. 011 the other hand, it also is possible that the exclusive use model would provide comparable benefits, such as in instances in which the price will he close to zero if spectrum is abundant and/or the burden of negotiating with rights holders will also be low. With low transaction costs as well as low price, interested users should have unrestricted access to tlir spectrum they need.

An important caveat must accompany any recoininendation for a coinmons model: If scarcity appears in particular speclruiii bands in the future, then a coiniiions model may no longer be appropriate for these bands. This approach is only efficient when there is little or 110 scarcity, since with a coininons there is no price mechanism to use as a tool for allocating scarce resources among competng users. The "price" of spectriiiii is essentially zero. With free access, however, comes the risk of interference and over-saturation, the classic problems of the "tragedy of the commons." These problems can he overcome to some extent through regulatory guidance, requirements such as power and emission limits. and sharing etiquettes. But where actual spectruiii scarcity exists, the tragedy of the coinmons may bc unavoidable because there are insufficient incentives to avoid overuse. Therefore, a spectruin commons approach iiiay be useful for some, brit iiot all. of the available spectruni.

The variables described above tend to tilt in favor of expanded use of rhe commons model in higher spectruiii hands, particularly above *40* GHz, based on the physical characteristics of the spectrum itself. In these bands, the propagation characteristics of spectruin preclude many of the applications that are possible in lower hands (e.g., mobile service, broadcasting), and instead favor short-distance line-of-sight operation using narrow transmission beams. Thus, these bands are well-suited to

accoiiiinodate multiple devices operating within a small area without interferencc. Moreover, administering these uses on an individualized licensed basis would involve very high transaction costs. Thus, the commons model inay have broader applicability in this portion of the spcctrum.

This does not, however, mean that only higher band spectrum should be subject io a commons approach. As many commenters point out, there is also value in having some lower band spectrum dedicated for commons use. much as there is benefit in having some land that could be developed commercially dedicated entirely to public use, such as parks. The record shows that the Commission's dedication of soiiie lower band spectrum to unlicensed uses, e.g., 2.4 GHz, is yielding significant technological and economic benefits in the form of low-power short-distance communications and emerging mesh network technologies that should be further encouraged. We therefore recommend that the coininons inodel continue to be used selectively in other lower spectrum bands if feasible.

Wc do not advocate the wholesale conversion of all spectrum to a coininons approach as soine commenters appear io advocate. Although the coininons inodel is in many ways a highly deregulatory "Darwinian" approach, as its proponents point out, productive iise of spectrum coiiiinons by unlicensed devices, particularly in lower spectrum bands, typically requires significant regulatory limitations on device transmitter power that preclude many other technically and economically feasible spectrum uses that rely on higher-power signal propagation over longer distances, or that require greater protection from interference. In addition, some commons proponents themselves state that setting aside additioiial spectruiii for use on a commons basis is not essential to the continued success of unlicensed technology because the technological capability exists to prevent congestion froin occurring in existing unlicensed bands. Furthernnre, supporters of mesh network architectures argue that this technology actually *expands* the capacity of the spectrum proportionately to demand.[68]

To the cxtent that new technologies are capable of operating on a non-interference basis with licensed uses, the proposal to create easeiiients "underneath" exclusive use licenses would provide additional capacity to soine types of users who otherwise would operate iii spcctrum devoted to commons use.

4. Limited Use of Command-and-Control

With respect to the coiiiinand-and-control inodel, as noted above, the Working Group recognizes tliat continued use of this approach inay be required in situations where prescribing spectrum use by regulation is necessary to accomplish compelling public interest objectives. However, such objectives should be carefully defined, and the amount of spectrum subject to a coininand-and-control regime should be limited to the minimum amount necessary to ensure that those objectives are achieved. Many spectrtiiii users will claim that they warrant special consideration aiid thus deserve exemption froin

[68] *See* Benkler, Yochai (2002) "Some Economics of Wireless Communications," 15 Harvard Journal of Law and Technology, forthcoming 2002-3, at 18.

any reform of their service allocation rules. It is therefore critical to distinguish between special interest and the public: interest, establishing a high bar for any service to clear prior to receiving an exemption.

In general, command-and-control regulation should he reserved only for spectrum uses that provide clear noli-market puhlic interest benefits. For example, radio astronomy may need to liave dedicated, protected spcctruin bands for the foresceable future. due to its highly sensitive applications and the fact that its benefits accrue to society as a whole and only over the long run. Public safety and critical infrastructure may also require dedicated spectruni at particular times to ensue priority access for emergency communications. Other examples where liinitcd use of command-and-control may be justified include spectruin uses that require regulatory prescription to avoid market failure (e.g., satellite allocations to ensure global harmonization of satellite frequency bands) or that liave it non-market dependent public interest basis articulated in the Communications Act (e.g., broadcasting). Some of these instances are discussed in greater detail iii Section IV below.

Subject to these exceptions, the Commission should eschew command-and-control regulation, and legacy coininand-and-control bands should he transitioned to iiiore tlexihle rules and uses to the maximum extent possible (whether under the exclusive rights or commons inodel). The Working Group's recommendations with respect to transition mechanisms are discussed in greater detail in Section V below.

III. Defining Specitic Rights and Obligations Within Spectrum Usage Regimes: Existing and Optimal Approaches

A. Flexibility

A theine implicit in much ofthe discussion in the Public Workshop and submitted comments was the tension between liceiisees' desire for certainty on the one hand and tlexihility on the other. It was often unclear exactly what type of flexibility parties wanted, but most agreed on general principles, such as (1j rilles should he tlexihle enough to accoinniodate future uses arid have just enough technical features to define rights; and (2) increased flexibility is good, hut interference criteria have to he clear. Flexibility in three areas was discussed: service or iise flexibility, such as would enable licensees to move their spectrum into higher valued uses; technical flexibility that would allow service providers to determine how best to coinhine inputs (e.g., using the newest or most cost effective technology): and the flexibility to subdivide, lease or transfer spectruin rights to others, so that compatible users are more likely to have access to the spectrum they need.[69]

The Working Group also posed the question of whether the Commission should develop more market-orienied spectrum rules that provide licensees with greater flexibility, and, if so, in which bands or services and how. The Working Group also

[69] *See, e.g.*, Information Technology Industry Council Comments at 8; Peha Comments at 2; CDMA Development Group Comments at 3-5; New America Foundation et al. Reply Comments at 11.

asked whether some limitations should be imposed on particular bands or services in order to achieve public interest objectives that would not be met under a purely market-based approach.

There was general agreement that more spectrum should be subject to market forcer in order to encourage innovation and enhance productivity through creative transactions with minimal transaction costs. For example, such a system would facilitate the introduction of broadband technologies by standardizing rules across spectrum blocks and making it easier to coordinate use with multipl licensees Some argued that the Commission should analyze carefully why it is not generally in the public interest to give all licensees much inore flexibility. At thr very least, instances in which flexible rules are not adopted should be the exception rather than the rule, should be tailored to meet specifically defined public interest goals, and should be applied to the least amount of spectrum necessary tn achicvc those goals.

Commenters state that in order to avoid uncertainty regarding the scope of llexibility afforded by our rules, the rules should he presumptively written (or re-written as necessary) to define spectrum rights in terms of spectrum uses that are excluded, prohibited, or limited. Thus. the Commission's approach should be that licensees and unlicensed users be allowed to do anything not explicitly prohibited by the rules, rather than the presumption being that anything not affirmatively authorized needs a rule change or waiver before it can be done.

Commenters and participants expressed broad support for both the development of secondary iiiarkets and greater implementation of the band manager concept.[70]

While the majority of commenters favored extending the curreiit system of auctioning spectruiii rights valid for a number of years with a presumption of renewal, several parties recommended that the government instead lease spectrum for shorter periods, and that leases be renewable.[71] It was suggested that a market would develop in lease rights, so that prices would accurately reflect short-term spectrum values in a way that auctions lor essentially perpetual right cannot do. Such a system would set a lower barrier to entry than certain auctions, and would make it quicker and easier to reclaim unused spectrum than current procedures permit. It was further argued that user Fees arc a means of making licensees bear the opportunity costs of inefficiency and of enabling the Treasury to receive revenue long-term instead of just at the time of initial license assignment. It was also acknowledged, however, that the FCC might face difficulties similar to those it has encnuntcred with installment payments if it were to rely on periodic lease payments. rather than lump sum payments for spectrum licenses.

---

[70] *See. e.g.*, Cisco Comments at 9; Statement of Peter Pitsch at the *Public Workshop on Spectrum Rights and Responsibilities*; Statements of Mark Crosby and Nancy Jesuale at the *Public Workshop on Interference Protection.*

[71] *See. e.g.*, Statements of Michael Calabrese and Larry Miller atthe *Public Workshop on Spectrum Rights and Responsibilities*; New America Foundation et al. Comments at 16-17; Wayne Longman (Longman) Comments and Reply Comments.