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Can You Hear Me Now?

Getting Better Reception from the FCC's Spectrum Policy

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I. INTRODUCTION

¶1 Use of the electromagnetic spectrum is growing at a staggering pace. Advances such as mobile phones, satellite television, and an array of novel public safety and national defense systems all depend on spectrum resources. These technologies have improved access to communications networks, distributed speech and entertainment more widely, and increased productivity.[1] But this growth comes at a cost. More intense use of the spectrum can lead to more "interference." Interference occurs when the radio signal of one spectrum user degrades equipment performance for another user.[2] As competition for spectrum resources intensifies, disputes over who bears the burden of interference have led to costly and frequent regulatory battles at the Federal Communications Commission ("FCC" or "Commission"). These disputes raise difficult legal, economic and political issues. Surprisingly, however, the FCC lacks an articulated and consistent standard for resolving the most important and complicated of these disputes.

¶2 Each time a new technology arises, a new use of a frequency band is proposed, or an "underlay" technology[3] seeks to share a band with an existing user, the Commission's interference rules are tested. When disputes erupt, the FCC must determine the amount of interference one spectrum user can permissibly cause to another. This is a difficult task, but nonetheless an important part of the larger goal of maximizing the utility of the nation's spectrum resource. Many politicians, academics, and industry analysts have argued for a number of years that the FCC does not have a spectrum

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[1] In Re Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993, Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services, 18 F.C.C.R. 12346, at 12985-13038 (2002) [hereinafter 2002 CMRS Competition Report].

[2] In Re Interference Immunity Performance Specifications for Radio Receivers, Review of the Commission's Rules and Policies Affecting the Conversion to Digital Television, 18 F.C.C.R. 6039, ¶ 4 (2003) [hereinafter Receiver Standards NOI].

[3] An "underlay" technology is one that is designed to operate at the same frequency as a previously existing service, but in a way that does not impermissibly interfere with the existing service, by, for example, operating at low power, or operating in locations or at times where the existing service is not operating. This arrangement could result in a more efficient overall use of the band. Examples are ultra-wideband devices, heart-monitoring devices, and some radio astronomy operations. See Spectrum Policy Task Force Report at 5.

policy that achieves this goal.[4] Maximizing utility is now becoming even more challenging because of the explosion of "Wi-Fi" wireless networks,[5] and as the Commission fields more calls for a "commons" approach to spectrum management.[6] The Clinton Administration, the FCC under Chairman William Kennard, and the current Bush Administration have offered studies, plans, and visions of how our national spectrum policy could be improved.[7]

¶3 Recently, the FCC under Chairman Michael Powell has entered this fray with its forward-thinking Spectrum Policy Task Force Report ("Task Force Report").[8] The Task Force Report recognizes the importance of addressing interference as part of increasing the utility of the spectrum resource.[9] It devotes substantial attention to interference issues, and suggests a potentially useful new way of measuring interference – "interference temperature."[10] The Report argues that adopting this new approach to measuring interference "could significantly enhance interference management."[11] The Commission could increase predictability for, and facilitate more efficient use of, spectrum resources by setting an easy-to-measure interference temperature for various bands that defines acceptable levels of interference in advance.

¶4 The Report concludes, however, that although new *quantitative metrics* are needed to measure interference, no improvement on the *legal interference standard* is necessary.[12] While the Report makes great strides in proposing the interference temperature metric, this conclusion could seriously undermine the FCC's spectrum policy goals. The legal interference standard must be improved.

¶5 Improving the interference standard is necessary because the interference temperature metric is a mere measuring tool. It tells the Commission how much interference exists in a particular band at a particular time. It does not, however, determine whether the measured level of interference is too high, too low, or just right according to the Commission's legal obligations and policy goals. To put the metric to use, the FCC will need to make this policy determination many times for many bands all across the spectrum. To do this in a way that promotes efficiency, and that is predictable and non-arbitrary, the FCC needs a *permissible interference standard*, not just a new technical metric. Unfortunately, such a standard does not exist today.

¶6 Part One of this article provides a brief technical background on interference, explains why establishing a permissible interference standard is needed in addition to the interference temperature metric, and explains the existing but inappropriate "interference" and "harmful interference"

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[4] *See, e.g.*, *The Future of Spectrum Policy: Hearing Before the S. Comm. on Commerce, Sci. and Transp.*, 108th Cong. XX (2003) (statement of Senator Conrad Burns); Comments of David P. Reed, Chief Technical Officer and Senior Vice President, Strategic Planning, CableLabs, to the Public Notice in ET Docket No. 02-135 (July 15, 2002); Comments of Rob Frieden, Professor of Telecommunications, Penn State University, to the Public Notice in ET Docket No. 02-135 (Jan. 8, 2003); Reply Comments of Thomas Hazlett, to the Public Notice in ET Docket No. 02-135 (July 18, 2002); Reply Comments of The New America Foundation, et. al., to the Public Notice in ET Docket No. 02-135 (July 22, 2002); Comments of The Telecommunications Industry Association, to the Public Notice in ET Docket No. 02-135 (Jan. 27, 2003).

[5] "Wi-Fi" is a generic term that refers to any IEEE 802.11 wireless network. *See generally* 2002 CMRS Competition Report, *supra* note 2, at 13061-63, for a discussion of Wi-Fi technologies and issues.

[6] *See, e.g.*, Yochai Benkler, *Some Economics of Wireless Communications*, 16 HARV. J.L. & TECH. 25, 76-81 (2002); Stuart Buck, *Replacing Spectrum Auctions with a Spectrum Commons*, 2002 STAN. TECH. L. REV. 2.

[7] *See* NAT'L TELECOMM. & I NFO. ASSOC., FEDERAL LONG-RANGE SPECTRUM PLAN, (2000), *available at* http://www.ntia.doc.gov/osmhome/LRSP/LRSP0.htm; In Re Principles for Reallocation of Spectrum to Encourage the Development of Telecommunications Technologies for the New Millennium, Policy Statement, 14 FCC Rcd. 19868 (1999); *Spectrum Management: Improving the Management of Government and Commercial Spectrum Domestically and Internationally: Hearing Before the S. Comm. on Commerce, Sci. and Transp.*, 107th Cong. PGXX (2002) (statement of Nancy Victory, Assistant Secretary, Communications and Information National Telecommunications and Information Administration, Department of Commerce), *available at* http://commerce.senate.gov/hearings/061102victory.pdf..

[8] FCC, SPECTRUM POLICY TASK FORCE REPORT (2002) [hereinafter TASK FORCE REPORT].

[9] *Id.* at 25-34.

[10] *Id.* at 27. *See infra* Part I.B. for a definition of spectrum temperature.

[11] TASK FORCE REPORT, *supra* note 9, at 30.

[12] *Id.* at 26 ("On balance, the Task Force concludes that the current general definitions of interference sufficiently address the broad operational and technical characteristics of the many communications services contained in the Commission's Rules. Rather, in lieu of suggesting that the Commission change or refine its definitions related to interference management, the Task Force believes that quantitative metrics can be used to augment and clarify the application of existing definitions.").

standards. Section Two analyzes the Commission's permissible interference determinations in the two most important recent spectrum disputes: the Multichannel Video Distribution and Data Service ("MVDDS") and the Ultra-wideband ("UWB") proceedings. This analysis demonstrates that the Commission has not articulated a workable permissible interference standard. Section Three proposes that the Commission issue a Notice of Inquiry with the goal of establishing a permissible interference standard. It suggests that the Commission: (1) state that the purpose of the permissible interference standard is to maximize total utility in each band rather than to minimize interference to any individual spectrum user; (2) recognize situations in which private transactions will not correct Commission mistakes in setting permissible interference temperatures; and (3) recognize the importance of limiting interference in certain critical bands, such as military bands, even if these limitations lead to less intensive spectrum use.

II. EFFICIENCY, PREDICTABILITY AND INTERFERENCE AT THE FCC

A. A Spectrum Primer

¶7 In order to understand why developing a permissible interference standard is important, it is critical to understand a few basic radio interference concepts.[13] A radio is anything that communicates information using electromagnetic waves that have a frequency in what is known as the "radio spectrum."[14] The currently usable radio spectrum runs from approximately 3 kHz to 400 GHz.[15] A "transmitter" generates a radio signal and feeds the signal to its antenna. The antenna transmits the signal at the speed of light. An antenna on a "receiver" picks up the signal when the signal reaches its position. The receiver then discriminates among all the signals it receives and determines which signal it has been programmed to obtain.

¶8 The ability of the receiver to pick up the desired signal can be degraded in a number of ways.[16] For example, as transmitter power decreases, and as distance between the transmitter and the receiver increases, it becomes harder for a receiver to obtain the signal. The signal can also be weakened before it reaches the receiver by environmental factors such as weather, foliage, and buildings. Both transmitter design and receiver design can increase or decrease the ability of the receiver to obtain the signal as well.[17]

¶9 Man-made radiation can also degrade a receiver's ability to pick up a desired signal. For example, when you drive past a radio tower you may occasionally notice that your car radio's reception is degraded, which manifests as static or the reception of some other radio station's programming.[18] Similarly, when you use your cordless phone near your microwave oven your phone's reception may degrade.[19]

¶10 To radio engineers, "interference" occurs when the ability of a radio receiver to pick up a desired signal is reduced by another radio signal, such as the signals emanating from the radio tower or the

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13 *See* Yochai Benkler, *Some Economics of Wireless Communications*, 16 HARV. J.L. & TECH. 25, 38-48 (2002) (providing useful background on radios and interference generally).

14 *See generally* CARL F. WEISMAN, THE ESSENTIAL GUIDE TO RF AND WIRELESS (1999) (providing an overview of radio concepts for non-engineers); NORMAN VIOLETTE, ET AL., ELECTROMAGNETIC COMPATIBILITY HANDBOOK (1987) (providing a more technical resource).

15 NAT'L TELECOMM. & INFO. ADMIN., UNITED STATES FREQUENCY ALLOCATIONS: THE RADIO SPECTRUM (1996).

16 *See* WEISMAN, *supra* note 15; VIOLETTE, *supra* note 15.

17 Receiver Standards NOI, *supra* note 3, ¶ 2.

18 Radio towers, mobile phones, satellites, and other devices that emit radio waves purposefully are known in FCC parlance as "intentional radiators." 47 C.F.R. § 15 (2002).

19 Microwave ovens, electric drills, and personal computers, which emit radio waves as a byproduct of their operation, are known in FCC parlance as "unintentional radiators." *Id.*

microwave oven in the examples above.[20] Basically, to successfully receive a signal, the power of the desired signal at the receiver must be somewhat greater than that of undesired signals.[21] It is important to note that degradation of the ability of a receiver to obtain a signal because of distance, environmental factors, transmitter design or receiver design may make a receiver far more susceptible to interference. These factors themselves, however, are not generally considered interference.[22]

B. The Spectrum Policy Task Force Report and the Interference Temperature Metric

¶11 The Spectrum Policy Task Force Report devotes substantial attention to interference. Most importantly, it suggests a potentially useful new way of measuring interference: "interference temperature."[23]

¶12 Proponents suggest that the interference temperature metric would measure the interference environment of a given band more accurately than the method currently used by the Commission.[24] Today the Commission gauges the interference potential of a band by focusing on transmitters, not receivers.[25] The more energy a given transmitter radiates into a particular band, and the closer that transmitter is to a receiver that considers the receiver's signal undesirable, the more potential for interference. But the Task Force Report recognizes that interference is felt at receivers, not transmitters.[26] What really matters for interference prediction purposes, therefore, is how much unwanted energy is experienced by receivers, not how much power is emitted from transmitters. So, to measure interference conditions more usefully, the Report suggests that the Commission could take the "temperature" of a band by measuring radio frequency power at various receiver locations at different times and in different conditions. The aggregate of this data could be combined into an "interference temperature" that is more useful than data on the power outputs and locations of transmitters.[27]

¶13 The Task Force Report argues that adopting this new approach to measuring interference "could significantly enhance interference management."[28] This enhancement would largely arise from two benefits of applying the new metric. First, "licensed spectrum users will obtain certainty with regard to the maximum permissible level of . . . interference" they must accept once the Commission sets the interference temperature in their band. Second, once the temperature is set, underlay

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[20] One of the primary jobs of the FCC is to regulate interference. In *Freeman v. Burlington Broadcasters, Inc.* , the Second Circuit recently explained the statutory basis for the Commission's regulation of interference as contained in the Communications Act.

> [U]nder subsection 302a(a)(1), the FCC has power to 'make reasonable regulations . . . governing the interference potential of devices which in their operation are capable of emitting radio frequency energy by radiation, conduction, or other means in sufficient degree to cause harmful interference to radio communications.' Section 303 grants extensive powers to the FCC to regulate radio broadcasting technology and RF interference phenomena. Among other powers, subsection 303(d) empowers the FCC to '[d]etermine the location of classes of stations or individual stations.' Subsection 303(e) empowers the FCC to '[r]egulate the kind of apparatus to be used with respect to its external effects and the purity and sharpness of the emissions from each station and from the apparatus therein.' Subsection 303(f) allows the FCC to '[m]ake such regulations not inconsistent with law as it may deem necessary to prevent interference between stations and to carry out the provisions of this chapter.' Subsection 303(h) confers 'authority to establish areas or zones to be served by any station.'

Freeman v. Burlington Broadcasters, Inc., 204 F.3d 311, 320 (2d Cir. 2000).

[21] *See* Benkler, *supra* note 14, at 38-48.

[22] For example, a group of Chicago broadcasters and television viewers asserted that the planned Sears Tower would cause "multiple ghost images" of television signals. They asked the FCC to block construction or otherwise reduce the chance of this occurrence. The FCC, and on appeal the Seventh Circuit, found that the FCC had no jurisdiction over the construction of the Sears Tower despite its statutory authority to regulate so as to reduce "harmful interference." Ill. Citizens Comm. for Broad. v. FCC, 467 F.2d 1397, 1401 (7th Cir. 1972).

[23] TASK FORCE REPORT, *supra* note 9, at 27.

[24] *Id.* at 30.

[25] *Id.* at 27.

[26] *Id.* at 27.

[27] *Id.* at 27-28.

[28] *Id.* at 30.

technologies[29] could increase spectrum efficiency by sharing the band with existing users, engaging in operations up to an easy-to-measure amount of "acceptable" in-band interference which is known ahead of time, and which would be defined as no greater than the interference temperature set by the Commission for that band. The Report explains:

> The Commission could use the interference temperature metric to establish maximum *permissible levels of interference*, thus characterizing the "worst case" environment in which a receiver would be expected to operate. Different threshold levels could be set for each band, geographic region or service, and these thresholds should be set after the Commission has reviewed the condition of the RF environment in each band.[30]

¶14 But how would the Commission set these *permissible levels of interference* for each band, even if it uses the new interference temperature metric? The technical metric alone can tell us how much energy is present at a certain frequency at a certain time and at a certain place. But, alone, it cannot tell us if this amount of energy is acceptable or unacceptable as a policy matter.

¶15 The limits of technical metrics become clearer in a more familiar context. Everyone knows that we have decided to measure the speed of cars on highways using a specific technical metric. We measure miles per hour on an absolute basis. We could choose another metric, by, for example, measuring relative speed and examining how fast a car is moving in relation to all other cars. But whatever metric we choose, we next must choose a standard that enables us to determine the *permissible speed*. Is it 45 MPH, 55 MPH, or 65 MPH for the road in question? This is a policy decision that may take estimates of lives lost, traffic congestion, and fuel economy into account. But merely knowing that we measure speed in miles per hour does not allow us to choose speed limits for each road that are not arbitrary and that are the right balance of costs and benefits.

¶16 To determine the permissible speed, and for the Commission to determine permissible interference, difficult policy decisions must be made. To make these policy decisions in a predictable and non-arbitrary way–and more effectively to implement the good new ideas of the Task Force Report–the Commission should have a legal standard that articulates the policy goals and factual considerations relevant to determining permissible interference. Unfortunately, it does not yet have such a standard.

C. The "Interference" and "Harmful Interference" Regulatory Definitions

¶17 The Commission frequently uses the terms "interference" and "harmful interference." These terms play an important role in spectrum regulation, but they are not adequate as permissible interference standards.

¶18 The Communications Act repeatedly uses the term "interference," but does not define it. The Commission defines "interference" by rule as:

> The effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radio-communications system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy.[31]

¶19 Taking this definition literally, every radio suffers interference constantly. This is because it is extremely difficult using today's technology to completely restrict signals to a particular frequency band. So, even when transmitters are designed to transmit in a certain frequency range, the signals they produce spill over into adjacent frequencies. Even if this spill-over energy is at a low level, it can be picked up by receivers tuned to that band. The performance of these receivers is frequently degraded by this energy, even if the degradation is minimal or can be avoided by measures taken by

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[29] *See supra* note 4.

[30] TASK FORCE REPORT, *supra* note 9, at 28 (emphasis added).

[31] 47 C.F.R. § 2.1 (2002).

the interferee.[32] Additionally, there are many "wideband" radiators, including electric drills and personal computers that "unintentionally" emit radio-frequency ("RF") energy, as well as ground-penetrating radar systems that "intentionally" emit RF energy.[33] These wideband devices emit energy over, as the name suggests, a wide swath of frequencies, rather than the more focused band used by narrowband technologies like cellular and television transmitters. A personal computer can, for example, emit signals all the way from 450 kHz to 5 GHz. A personal computer therefore may emit "unwanted energy . . . in a radio-communication system" and, because even small amounts of energy can marginally degrade performance, such as at the fringes of reception, it may be "interfering" under the FCC rule.

¶20 Luckily for personal computer manufacturers, and everyone else, mere "interference" is not prohibited in most bands. If all interference were prohibited, the ability to use spectrum resources would be severely limited. Because virtually every transmitter emits small amounts of unwanted energy in frequency bands where they are not licensed to operate, they could theoretically be construed as potential sources of interference to receivers in almost any other radio service. These spectrum users and the FCC probably would find it difficult to determine where the interfering energy was coming from, making enforcement problematic. In any case, the interfering energy usually occurs at such low levels that engineers can design their systems so that there is no noticeable degradation of performance.[34]

¶21 Radio engineers can design systems to tolerate more or less interference, much in the way that automobile engineers can design cars to withstand more or less force in collisions.[35] But more interference protection, like more collision protection, means more cost in many situations. This cost can be financial (*i.e.*, buying more sophisticated equipment or adding shielding), or can come in the form of inferior performance (*i.e.*, degrading capability when protections are added). Engineers must therefore decide whether the added cost of each additional step they can take to protect against interference is worth the benefit to their company. Understandably, spectrum users try to avoid expensive interference protections where they can do so.

¶22 But the question of whether the costs of building a more robust system are worth the benefits of allowing more activity in a band *overall to society* is more complicated. The costs of installing additional protections may, for an individual company, be greater than the benefits. But the resulting fragile system may be worse for spectrum policy overall because it means that no other spectrum user can share the band without causing substantial interference, thereby reducing the efficient use of spectrum resources.[36]

¶23 So the FCC's rules on what constitutes permissible interference should be examined both from the perspective of individual spectrum users and overall good to society. If the FCC allows too much interference, then the cost of building robust protections may outweigh the benefits of sharing the band. Conversely, if the FCC allows too little interference, the cost savings of designing fragile systems will be outweighed by the cost of precluding sharing of the band by other users.

¶24 Weighing these costs, the FCC wisely does not use its "interference" definition to insist that spectrum users cause no interfere to any other user.[37] Wireless phone networks, car radios, and

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[32] For example, the interferee might use a receiver that better discriminates among signals or increase the power of its competing transmitter.

[33] FCC regulations define an "intentional radiators" as a device that "intentionally generates and emits radio frequency energy by radiation or induction." An "unintentional radiator" is a device that "intentionally generates radio frequency energy for use within the device, or that sends radio frequency signals by conduction to associated equipment via connecting wiring, but which is not intended to emit RF energy by radiation or induction." Intentional radiators are regulated more strictly than unintentional radiators. 47 C.F.R. § 15 (2002).

[34] Receiver Standards NOI, *supra* note 3, ¶ 5.

[35] TASK FORCE REPORT, *supra* note 9, at 31; *see also* Receiver Standards NOI, *supra* note 3, ¶ 10.

[36] Receiver Standards NOI, *supra* note 3, ¶ 2.

[37] *See infra* Part II.

airplane guidance systems are all therefore designed to withstand a certain level of unwanted energy without unacceptable degradation in performance.

¶25 But Commission rules generally do not allow high levels of interference. While the Commission permits "interference" in most cases, it generally prohibits "harmful interference."[38] The FCC defines "harmful interference" as "[i]nterference which endangers the functioning of a radionavigation service or other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with [international] Radio Regulations."[39]

¶26 The harmful interference standard has provided the Commission with a useful tool in many types of interference disputes. When one licensee alleges that another licensee has inflicted an impermissible level of interference on it, the Commission turns to the harmful interference standard.[40] In disputes where the Commission can analyze a particular instance of interference, receive pleadings on the exact impact of the interference on a licensee's operations, and measure the power levels and locations of existing transmitters and receivers, the harmful interference standard has been helpful. The standard recognizes that it is difficult to quantify exactly how much interference is too much for a particular case. Many different factors can come into play, and the harmful interference standard allows the FCC the flexibility to know interference when it sees it. This flexibility is an important asset of the standard in these types of cases, much like the flexibility of the antitrust standard and the obscenity standard is an asset for other types of disputes.

¶27 The test of the Commission's flexible definition of "harmful interference" certainly suggests that harmful interference represents something more serious than mere "interference." But the definition includes several undefined terms and concepts that make it difficult to apply consistently. When does interference endanger the functioning of another radio? What does seriously degrade or obstruct mean in practical terms? Is interference repeated if it occurs just twice? When it occurs only once but for more than some undefined period of time? When it occurs only once but to more than one other radio? What if the interference can be mitigated by some simple and inexpensive action by the interferee? The FCC rules do not answer these questions. Therefore, we must turn to applications of the harmful interference standard to see if courts or the FCC have established precedent that focuses this amorphous standard.

¶28 Federal courts have cited the harmful interference standard many times over the past 15 years. Some courts have found FCC decisions related to harmful interference non-arbitrary, but have never directly discussed the standard itself.[41] Additionally, no court has discussed whether the definition is

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[38] 47 C.F.R. § 2.1 (2002). Note that this does not always hold true. In some cases "interference" is prohibited, and in others "harmful interference" is permitted.

[39] *Id.*

[40] *See, e.g.*, In Re Schroeder Manatee Ranch, Memorandum Opinion & Order, 16 FCC Rcd. 5722, ¶ 3 (2001) ("If the parties in good faith are unable themselves to resolve the interference conflict, the Commission may impose restrictions including specifying the transmitter power, antenna height, or area or hours of operation of the stations.").

[41] Teledesic LLC v. FCC, 275 F.3d 75, 79-80 (D.C. Cir. 2001) (discussing harmful interference to fixed satellite service systems without examining whether harmful interference standard is arbitrary, but discussing whether other aspects of Order were arbitrary); AT&T Wireless Servs., Inc. v. FCC, 270 F.3d 959, 961 (D.C. Cir. 2001) (discussing potential harmful interference from cellular operations in aircraft to terrestrial cellular operators; quoting FCC order defining harmful interference, but does not elaborate); Freeman v. Burlington Broadcasters, Inc., 204 F.3d 311, 320 (2d Cir. 2000) (discussing FCC authority to regulate to prevent harmful interference without examining standard); Rocky Mountain Radar, Inc. v. FCC, 158 F.3d 1118 (10th Cir. 1998) (discussing harmful interference and radar jammer equipment without examining standard); W. Radio Servs. Co v. Espy, 79 F.3d 896, 903 (9th Cir. 1996) (using the term "economically harmful interference" in relation to competing radio towers, without exploring standard); Achernar Broad. Co. v. FCC, 62 F.3d 1441 (D.C. Cir. 1995) (finding FCC acted arbitrarily in denying radio station a license due to potential "harmful interference" with radio astronomy facility, but without examining standard); Aeronautical Radio, Inc., v. FCC, 928 F. 2d 428 (D.C. Cir. 1991) (finding FCC allocation decision related to satellite services and harmful interference to be non-arbitrary, but not discussing standard itself); Computer Sys. of Am., Inc. v. Data Gen. Corp., 921 F.2d 386 (1st Cir. 1990) (discussing potential harmful interference from computing devices without examining standard); Am. Radio Relay League, Inc. v. FCC, 617 F.2d 875 (D.C. Cir. 1980) (briefly discussing FCC statutory authority to regulate to prevent harmful interference without examining standard); Ill. Citizens Comm. for Broad. v. FCC, 467 F.2d 1397, 1401 (7th Cir. 1972) (finding the FCC has no jurisdiction to block the construction of the Sears Tower based on the potential for "multiple ghost images" of TV signals despite harmful interference authority, without examining standard); Bendix Aviation Corp., Bendix Radio Div. v. FCC, *272* F.2d 533 (D.C. Cir 1959) (discussing potential harmful interference in relation to aircraft collision avoidance systems without examining standard*);* C.J. Cmty. Servs., Inc. v. FCC, 246 F.2d 660 (D.C. Cir. 1957) (discussing potential harmful

overly vague. This is somewhat surprising, as the FCC constantly makes use of the harmful interference standard in high-profile spectrum disputes.[42] Most Commission actions related to harmful interference, however, do not elaborate or improve upon the minimal definition contained in the FCC rules. Furthermore, most of these proceedings deal with out-of-band interference and the type of retrospective disputes described above, rather than setting prospective permissible interference levels.

¶29 The harmful interference standard can be useful in arbitrating such retrospective disputes over whether an individual instance of interference was impermissible. However, while the definition's flexibility may be an asset when used for retrospective disputes, it becomes a serious liability when used as a tool for prospectively determining permissible levels of interference for new band plans or new technologies. It was designed to determine when interference *has occurred* in individual cases between existing users, not whether an impermissible level of interference *might occur* in the future if a certain band plan is adopted or a new technology licensed. In these cases, the definition's flexibility leads to vagueness and inconsistency, as evidenced in the two most important spectrum disputes that the FCC has recently faced.

III. RECENT SPECTRUM BATTLES

¶30 In the two most important recent disputes, the Commission struggled to establish permissible levels of interference without a well-articulated standard. Lacking this tool, the Commission relied heavily on the harmful interference standard. While the FCC acted properly given the lack of an appropriate permissible interference standard, reliance on the imperfect harmful interference standard undermined predictability and increased exposure to arbitrariness challenges.

¶31 In 2002 the Commission issued major orders related to the Multichannel Video Distribution and Data Service ("MVDDS") and ultra-wideband ("UWB") technologies. The MVDDS proceeding established a new competitor of cable and satellite television service. MVDDS providers hope to use wireless technology to deliver video programming to consumers.[43] The UWB proceeding licensed a paradigm-challenging new wireless technology that promises to enable see-though-wall and ground-penetrating radars for law enforcement and rescue crews, low-power, high-throughput wireless Internet services, and many other innovations.[44]

¶32 In establishing MVDDS and licensing UWB devices, the Commission was forced to determine the "permissible" levels of interference[45] these new spectrum users could cause to existing spectrum

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interference by "booster station" for TV signals in rural town without examining standard).

[42] *See, e.g.*, In Re Amendment of Parts 2, 25 and 97 of the Commission's Rules with Regard to Mobile-Satellite Service Above 1 GHz, Report and Order, 17 FCC Rcd. 2658, ¶¶30, 47 (2002) (setting various power flux density limits to avoid harmful interference in relation to mobile satellite service without addressing standard); In Re 1998 Biennial Regulatory Review, 47 C.F.R. Part 90, Private Land Mobile Radio Services, Report and Order and Further Notice of Proposed Rule Making, 15 FCC Rcd. 16673, ¶8 (2000) (regulating "non-cargo operations" communications so as to minimize chance of harmful interference without examining standard); In Re AirCell, Inc., Order, 14 F.C.C. R. 806 (1998) (addressing harmful interference concerns of terrestrial wireless carriers related to operations of wireless service from aircraft without examining standard); In Re 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, Third Order on Reconsideration, 13 F.C.C.R. 4856, ¶¶ 2, 131, 139, 168 (1998) (involving interference dispute between LMDS and incumbent licensees without examining standard).

[43] In 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; 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, Memorandum Opinion and Order and Second Report and Order, 17 F.C.C. R. 9614 (2002) [hereinafter MVDDS MO&O and Second R&O].

[44] In Re Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, First Report and Order, 17 F.C.C. R. 10505 (2002) [hereinafter UWB First R&O]. *See also* In Re Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, Memorandum Opinion and Order and Further Notice of Proposed Rulemaking, 18 F.C.C.R. 3857 (2003) (responding to several petitions for reconsideration and largely leaving the First Report and Order's decisions and reasoning in place).

[45] I'll use this Task-Force-Report-derived term, TASK FORCE REPORT, *supra* note 9, at 28, throughout this article because the Commission has not yet established another term for this concept. Note, however, that while the Task Force Report itself uses the

users. These determinations were quite similar to policy decisions a future Commission will have to make when using the interference temperature metric to set permissible interference levels for other underlay technologies in various bands.[46] In setting permissible interference levels, the Commission attempted to balance a number of competing values and factors in each proceeding. In each case the FCC made determinations by invoking the harmful interference concept. It did not have a permissible interference standard that would have enabled it to make more predictable and consistent decisions, and to produce results that would have been easier to defend against arbitrariness challenges.[47]

A. The MVDDS Dispute

¶33 The FCC allocated frequencies in the 12.2-12.7 GHz band ("the 12 GHz band") for use by Direct Broadcast Satellite ("DBS") operators in 1982.[48] DBS operators such as DirecTV and EchoStar offer consumers multichannel video services, often in competition with cable television providers.[49] They transmit their signals from satellites to dishes located at their customers' premises.[50]

¶34 In 1998, Northpoint Technology, Ltd. petitioned the Commission to license a terrestrial multichannel video and broadband data service in the 12 GHz band.[51] DBS operators protested, arguing that the new service would interfere with their signals to an unacceptable extent.[52] After complicated and fractious procedural battles, applications, waiver requests, and legislative mandates, the Commission concluded that the new fixed terrestrial MVDDS could operate in the 12 GHz band on a co-primary non-harmful interference basis with incumbent BSS (the more generic term for DBS) providers.[53] The Commission stated in this Order that it would "define MVDDS technical rules and requirements in a later order that would protect BSS operations."[54] In other words, the FCC stated that, having determined that MVDDS could use the 12 GHz band without causing harmful interference to incumbents, it would next determine the permissible level of interference that this new service could cause to the incumbents, and how to cap that level of interference.

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term "permissible interference", it also states that the Commission should "[h]armoniz[e] . . . references to interference in the Commission's regulations: to ensure a consistent understanding of the impact of interference qualifiers such as *harmful*, and to remove or clarify undefined terms such as *objectionable* . . . ." TASK FORCE REPORT, *supra* note 9, at 32.

46 *See id.* at 27.

47 This article's analysis is limited to the MVDDS and UWB disputes, but the interference disputes concerning airborne cellular service, *see* In Re AirCell, Inc., Order, 14 FCC Rcd. 806 (1998), and terrestrial repeaters used by Satellite Digital Audio Radio Service ("SDARS") licensees, *see* In Re XM Radio, Inc., Order, 16 F.C.C.R. 18484 (2001); In Re Sirius Satellite Radio, Inc., Order, 16 F.C.C.R. 18481 (2001), are also important and worth examining for those interested in the current difficulties the Commission faces in interference disputes.

48 BENNETT Z. KOBB, WIRELESS SPECTRUM FINDER: TELECOMMUNICATIONS, GOVERNMENT, AND SCIENTIFIC RADIO FREQUENCY ALLOCATIONS IN THE U.S. 30 MHZ – 300 GHZ 309 (2001).

49 *See* http://www.directv.com (last visited DATE?); http://www.dishnetwork.com (last visited DATE?).

50 While the Commission struggled with how to allow sharing between both DBS and MVDDS and NGSO FSS and MVDDS, for the sake of brevity, I will restrict my analysis here to its rules for DBS/MVDDS sharing.

51 In Re Northpoint Technology, Petition for Rule Making To Modify Section 101.147(p) of the Commission's Rules To Authorize Subsidiary Terrestrial Use of the 12.2-12.7 GHz Band By Digital Broadcast Satellite Licenses and Their Affiliates(Mar. 6, 1998), *available at* http://gullfoss2.fcc.gov/prod/ecfs/comsrch_v2.cgi [hereinafter *NorthPoint Petition*]. Note that it was actually the satellite company SkyBridge that first filed a Petition for Rulemaking related to this service. In Re Amendment of Parts 2.106 and 25.202 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the 10.7-12.7 GHz, 12.75-13.25 GHz, 13.75-14.5 GHz, and 17.3-17.8 GHz Bands, and to Establish Technical Rules Governing NGSO FSS Operations in these Bands, (July 3, 1997).

52 *See, e.g.*, Comments of DirecTV, Inc., to Notice of Proposed Rule Making in ET Docket No. 98-206 (Mar. 2, 1999); Comments of EchoStar Communications Corp., to ET Docket No. 98-206. (Mar. 2, 1999).

53 MVDDS MO&O and Second R&O, *supra* note 44, ¶ 11. *See also* In 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; 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, First Report and Order and Further Notice of Proposed Rule Making, 16 F.C.C.R. 4096 (2000)..

54 MVDDS MO&O and Second R&O, *supra* note 44, ¶ 11.

¶35 It did so in May, 2002.[55] Drawing heavily on a congressionally mandated independent study of interference in the 12 GHz band conducted by MITRE Corp.,[56] the Commission established complicated technical criteria for sharing the band. In doing so the FCC explicitly established a "permissible"[57] level of interference, much as a future Commission will have to do when establishing "interference temperatures." In the MVDDS Order the Commission merely used a different technical measure of interference.

¶36 In order to determine the permissible level of interference the Commission first found that "a strict non-interference"[58] standard was overprotective. Such a standard would practically mean that MVDDS could not operate at all. The Commission concluded that "the relatively small theoretical changes in DBS unavailability . . . that might result from MVDDS operations" were "outweighed by the benefits of adding new services or capabilities to a frequency band."[59] The Commission also stated that "any impacts of incumbent BSS . . . to accommodate MVDDS in this band are outweighed by the potential benefit to the public of providing for a new potential competitor in the multichannel video and data markets."[60]

¶37 Next the Commission found that "the service is prohibited from causing harmful interference" to DBS.[61] However, the FCC defined "harmful interference" only with a reference to the definition contained in its rules, the limits of which are discussed in the previous section.[62] The Commission did not elaborate or tighten this definition, discuss its imprecision, or discuss the challenges of applying a standard designed for retrospective disputes to a prospective policy decision. The Commission stated only that it sought a compromise that was a "reasonable balance of the parties' competing interests", and that lay somewhere between an inefficient no-interference standard and the difficult harmful interference standard.

¶38 The compromise the Commission settled on was that "permissible interference" occurs if MVDDS interference increases the baseline DBS outage rate by ten percent per year.[63] It is important to note that this means ten percent of DBS's current outage rate, so that a ten percent increase of a typical 0.02 percent unavailability rate would increase DBS unavailability by only 0.002 percent, usually a few minutes over a whole year.[64] It does not mean that DBS services would be unavailable to consumers 10 percent of the time. The Commission sought to protect DBS from interference above this permissible level by not only limiting additional DBS service interruptions due to MVDDS to "a negligible level" more than current DBS service interruptions,[65] but also by: (1) limiting MVDDS operators to a maximum power limit;[66] (2) dividing the country into four regions and specifying an effective power flux density ("EPFD") limit for each region;[67] and (3) requiring

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55 *Id.*

56 MITRE CORP., ANALYSIS OF POTENTIAL MVDDS INTERFERENCE TO DBS IN THE 12.2-12.7 GHZ BAND (2001).

57 MVDDS MO&O and Second R&O, *supra* note 44, ¶ 54.

58 *Id.* ¶ 60.

59 *Id.* ¶ 32.

60 *Id.* ¶ 53.

61 *Id.* ¶ 54.

62 *See* FCC Terms and Definitions, 47 C.F.R. § 2.1 (2002).

63 Note that individual locations may experience more than ten percent increase in unavailability since the Commission measures the ten percent rate by averaging unavailability rates over large geographic areas and a set time period, meaning that some locations may experience more or less than a ten percent increase. *See* MVDDS MO&O and Second R&O, *supra* note 44, ¶ 71 (Martin, Commissioner, dissenting in part and approving in part).

64 MVDDS MO&O and Second R&O, *supra* note 44, ¶ 67 ("To place this matter in perspective, it is important to bear in mind that DBS is, on the whole, extremely reliable with typical service availabilities on the order of 99.8 to 99.9 percent.").

65 *Id.* ¶ 4.

66 The limit is 14 dBm per 24 megahertz Effective Isotropic Radiated Power ("EIRP"). *Id.*

67 The limits are -168.4 dBW/m^2/4hHz (East), -171.0 dBW/m^2/4hHz (Southwest), -169.8 dBW/m^2/4hHz (Midwest), and -172.1 dBW/m^2/4hHz (Northwest). *Id.*

MVDDS operators to "site and design [their] transmitting antennas to avoid causing harmful interference to existing DBS customers."[68]

¶39 But why was a ten percent increase in unavailability the correct "permissible" level of interference? The Commission offered a number of answers: (1) the independent MITRE Report suggested that the alternative 2.86 percent increase suggested by DBS operators "seems very small" and because "there is precedent for a ten percent increase" in previously negotiated spectrum sharing arrangements between satellite providers in the same band;[69] (2) "[t]he ten percent benchmark represents an insubstantial amount of increased unavailability;"[70] (3) "the increased unavailability will not be perceptible to DBS customers in most cases;"[71] and (4) a ten percent difference is less than variations due to "seasonal or yearly variability" or "the variability in actual rainfall rates."[72]

¶40 But none of these explanations lead exclusively to a decision that a ten percent increase in outage rates is permissible. Each explanation could support many other levels of permissible interference, such as an eight percent or twelve percent increase in unavailability. The only explanation that seems to lead exclusively to ten percent is that ten percent was chosen as the rate in a previous spectrum sharing arrangement between satellite operators in the same band. But the fact that these satellite providers agreed to ten percent in the past does not tie the Commission to this number in this case. The satellite providers' choice of ten percent was the result of a negotiation between a specific set of companies about what interference they could tolerate, not a decision by the Commission that this level of interference would be appropriate for any new service, such as MVDDS. The Commission itself seems to recognize this. Although it professes to aim at a ten percent level with its rules, the FCC understands that at times it will allow unavailability rates that are considerably higher than this. If the ten percent level for satellite-to-satellite sharing was the only appropriate level, this would not be acceptable.[73] This imprecision leaves the Commission more vulnerable to an arbitrariness challenge than would be the case had it used a consistent permissible interference standard to create the MVDDS rules.

¶41 The approach the FCC took in the MVDDS dispute was appropriate given the tools at the Commission's disposal.[74] Without an articulated permissible interference standard, the Commission could only try to "balance between protecting DBS customers from interference, minimizing the impact of DBS operators' ability to make adjustments to their networks, and not unduly constraining the deployment of MVDDS" as best as it could in this individual proceeding. In doing so, it had to seek an answer that it had not equipped itself to find in a consistent way across proceedings. In the end, all it could do was reassure us that the permissible interference it has allowed was conservative enough that the murky harmful interference standard was not violated.

B. The Ultra-Wideband Dispute

¶42 The Commission faced this dilemma again in setting the permissible level of interference caused by ultra-wideband ("UWB") devices to incumbent spectrum users.[75] Here, the Commission found itself in an even more difficult position than it did in the MVDDS dispute. In addressing MVDDS, it struggled with determining the permissible level of interference for one new service in one frequency

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[68] *Id.* Note that the Commission established several other technical rules that will not be discussed in this article, related to, for example, measurement methods and flexibility for anomalous situations.

[69] *Id.* ¶ 66.

[70] *Id.* ¶ 72.

[71] *Id.* ¶ 71.

[72] *Id.*

[73] For a discussion of the separate question of whether the Commission's technical rules for determining whether the 10 percent increase in unavailability level has been surpassed, see MVDDS MO&O and Second R&O, *supra* note 44.

[74] It is understandable, if for no other reason, because "harmful interference" even if undefined, is contained in several applicable statutes and allocation table entries.

[75] UWB First R&O, *supra* note 45.

band.[76] The UWB dispute required the Commission to create rules for new devices that could interfere with dozens of frequency bands across a huge swath of the most densely packed portion of the radio spectrum.[77]

¶43 The Commission defined UWB as follows: "UWB devices operate by employing very narrow or short duration pulses that result in very large or wideband transmission bandwidths."[78] Most radios are designed to emit energy at a particular frequency or a small set of frequencies; thus they are known as "narrowband" devices. UWB devices, on the other hand, are designed to emit energy across a huge frequency range; thus they are "wideband" devices. By emitting across a wide frequency range, UWB devices can theoretically operate at very low power, transmit large amounts of information per second, and can transmit through physical obstacles that would block narrowband signals.[79]

¶44 Here, again, it is important to make a distinction between intentional and unintentional radiators. Many devices already unintentionally radiate wideband energy. For example, computer monitors and power drills emit energy over an extremely wide frequency range. The Commission's recent proceeding, however, concerned intentional UWB radiators. Technologists hope to use intentionally radiating UWB devices for radars, communications devices, and surveillance systems.[80] Unintentional radiators were already permitted to operate on an unlicensed basis up to the "Part 15" power limits in many bands.[81] These devices were not the subject of the UWB proceeding, and a discussion of the wisdom of treating intentional and unintentional radiators differently is beyond the scope of this article.

¶45 UWB manufacturers and some technology reporters have claimed that UWB is an innovation that will revolutionize wireless technologies because of its power, capacity, and attenuation characteristics.[82] Many incumbent spectrum users are more circumspect. The National Telecommunications and Information Administration ("NTIA"), the Department of Defense and the Department of Transportation,[83] the Global Positioning Satellite ("GPS") industry, [84] satellite companies,[85] wireless phone companies, [86] and other important spectrum users [87] have expressed concern that UWB devices emitting energy across each of their assigned frequencies will result in unacceptable interference to their systems.

¶46 In April 2002, the Commission decided to license UWB devices for the first time. It concluded that: "With appropriate technical standards, UWB devices can operate using spectrum occupied by existing radio services without causing interference, thereby permitting scarce spectrum resources to be used more efficiently."[88] In order to set "appropriate technical standards," however, the Commission had to determine what level of "interference" incumbents should suffer in order to

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[76] MDVVS MO&O and Second R&O, *supra* note 44.

[77] UWB First R&O, supra note 45, at ¶¶ 1-10.

[78] *Id.* ¶ 1.

[79] *See* Kathy Chen & Yochi J. Dreasen, *Ultrawideband Gets FCC Nod, Despite Protests: New Technology to Extend Wireless Applications Available to Consumers*, WALL ST. J., Feb. 15, 2002, at B5.

[80] *See, e.g.*, http://www.timedomain.com; http://www.xtremespectrum.com; http://www.multispectral.com.

[81] FCC Equipment authorization of unintentional radiators, 47 C.F.R. §15.101 et seq (2002).

[82] *See, e.g.*, Comments of Time Domain Corp., to the Notice of Inquiry in ET Docket No. 98-153, 10-22 (Dec. 7, 1998); Comments of XtremeSpectrum, Inc., to the Notice of Inquiry in ET Docket No. 98-153 (Sept. 12, 2000); Robert X. Cringely, *The 100 Mile-Per-Gallon Carburetor: How Ultra Wide Band May (or May Not) Change the World*, at http://www.pbs.org/cringely/pulpit/pulpit20020124.html (Jan. 24, 2002).

[83] NAT'L TELECOMM. & INFO. ADM., U.S. DEP'T OF COMMERCE, NTIA SPECIAL PUBLICATION 01-45: ASSESSMENT OF COMPATIBILITY BETWEEN ULTRAWIDEBAND (UWB) SYSTEMS AND GLOBAL POSITIONING SYSTEM (GPS) RECEIVERS (2001).

[84] Comments of The U.S. GPS Industry Council, to the Public Notice in ET Docket No. 98-153 (Apr. 25, 2001).

[85] *See, e.g.*, Comments of Lockheed Martin Corp., to the Public Notice in ET Docket No. 98-153 (Apr. 25, 2001).

[86] *See, e.g.*, Comments of Sprint Corp., to the Public Notice in ET DocketNo. 98-153 (Apr. 6, 2001).

[87] *See, e.g.*, Supplemental Comments of the Boeing Co., to the Public Notice in ET Docket No. 98-153 (Apr. 23, 2001); Comments of the National Association of Broadcasters, to the Public Notice in ET Docket No. 98-153 (Feb. 23, 2001).

[88] UWB First R&O, *supra* note 45, ¶ 1.

achieve more "efficien[cy]."[89] This determination, like that in MVDDS, is very similar to the determination a future Commission will have to make in setting "interference temperatures" in various bands in furtherance of the vision of the Spectrum Task Force Report.

¶47 In its attempt to protect existing spectrum users from impermissible interference, the Commission devised a complicated set of restrictions on various types of UWB applications.[90] Ground penetrating radar, wall imaging, through-wall imaging, surveillance, medical applications, vehicular radar, and communications and measurement systems are each restricted differently.[91] Each application has specific frequency and power restrictions. Some applications have detailed design mandates. The Commission restricted use of some types of devices to specified classes of users, such as law enforcement, fire and rescue, public utility, commercial mining, construction, and/or licensed health care users.[92]

¶48 In some frequency bands UWB use is severely limited. For example, in the GPS band, UWB devices must restrict emissions to 1/100th the energy emitted by existing UWB unintentional radiators such as computer monitors or power drills.[93] In others bands, these devices can operate up to the full Part 15 limits that govern unintentional radiators.[94]

¶49 But what permissible interference standard was used to set these technical rules? The Commission did not articulate a clear standard. It did, however, as in the MVDDS dispute, try to balance costs and benefits. First the Commission made it clear that incumbent spectrum users do not have the right to exclude new users from emitting energy into their assigned bands. Sprint, one such incumbent licensee, had "objected to the basic concept of UWB operation, stating that the Commission does not have a legal right to convert Sprint's licenses into non-exclusive licenses and to require Sprint PCS to share its spectrum with others, much less share it for free."[95] Sprint's argument was that it had "spent over $3 billion for exclusive" spectrum rights, and that "Commission authorization of new users constitutes breach of contract and an unlawful modification of licenses for which the Government would be liable for damages."[96]

¶50 The Commission firmly rejected this argument for a zero-interference level. It stated that:

> [S]pectrum is not, and has never been, exclusive to Sprint or to any other licensee or user. While Sprint PCS has been provided some exclusivity in operating licensed PCS systems within specified geographic areas, Part 15 transmitters [such as personal computers and electric drills] currently are permitted to operate within the PCS and cellular frequency bands . . . [and] there are countless other devices that emit radio emissions within these bands.[97]

¶51 As to Sprint's contract claim, the Commission stated that "no such contractual exclusivity exists."[98]

¶52 It is worth noting that the Commission side-stepped a potentially important point here, stating that "[i]n any event, we have not in this proceeding permitted any UWB devices to deliberately emit in the PCS bands. Much as we have done for other RF [radiofrequency] devices, we have simply established limits on out-of-band and spurious emissions from UWB devices . . . ."[99]

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89 *Id.* ("With appropriate technical standards, UWB devices can operate using spectrum occupied by existing radio services without causing interference, thereby permitting scarce spectrum resources to be used more efficiently.").

90 *Id.* ¶ 5.

91 *Id.*

92 *Id.*

93 See emission limits for various devices in UWB First R&O, *supra* note 45, ¶¶ 33-69.

94 *Id.*

95 *Id.* ¶ 271.

96 *Id.*

97 *Id.*

98 *Id.*

99 *Id.*

¶53 The Commission felt comfortable saying here that an UWB emission in the PCS band is spurious rather than "deliberate," but did not explain how it determined that the expected wideband emissions of an UWB device are, in fact, "out-of-band" or "spurious." In addition, the Spectrum Task Force Report's interference temperature concept envisions allowing clearly "deliberate" emissions into various bands.[100] Thus, the Commission's use of the words "[i]n any event" [101] before its discussion of the out-of-band or spurious nature of UWB emissions becomes particularly important, because these words imply that its rejection of Sprint's argument did not rest on UWB emissions being out-of-band or spurious. Without a rejection of Sprint's claims as they relate to in-band, intentional emissions, the vision of the Spectrum Task Force Report would be extremely difficult to achieve.

¶54 Having rejected a zero-interference policy, as it did in the MVDDS proceeding, the Commission turned to the "harmful interference" standard. The FCC stated that it is:

> [C]ognizant . . . that the substantial benefits of UWB technology could be outweighed if UWB devices were to cause interference to licensed services and other important radio operations. Our analysis of the record and the various technical studies submitted indicates that UWB devices can be permitted to operate without causing harmful interference if appropriate technical standards and operational restrictions are applied to their use.[102]

¶55 The Commission did not, however, attempt to define "harmful interference," and did not reference the definition contained in its rules. Without discussing the harmful interference standard's imprecision, or the challenge of applying a retrospective standard to a prospective policy decision, the Commission proceeded to rely on the problematic harmful interference standard as it imposed each of dozens of technical rules on UWB devices.[103]

¶56 A close reading of the Order shows that, as in the MVDDS dispute, the standard again served as more of a safety net than a real decisional tool. Faced here with both a difficult to administer standard and incomplete information on the real-world impact of the new and untested UWB technology, it is understandable that the Commission shied away from setting a permissible level of interference anywhere near the harmful interference level. Instead, it acted with "an abundance of caution,"[104] and set "conservative"[105] rules that "may be overprotective."[106]

¶57 It established limits on UWB that are "significantly more stringent than those imposed on other Part 15 devices . . . ."[107] Some of the protections limit UWB emissions "to levels below the receiver thermal noise floor . . . a level of performance that does not generally occur under actual operating conditions due to the presence of other sources of radio noise."[108] The Commission even stated that it set its extremely conservative limitations substantially below the Part 15 limits even though "there were only a few instances where UWB systems operating [at the higher full Part 15 limits] demonstrated a clear potential to cause harmful interference . . . ."[109] Elsewhere, the Commission stated that rather than protecting against harmful interference, "we are implementing a reduction to the Part 15 general emission levels over certain frequency bands to ensure that our introduction of

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100 TASK FORCE REPORT, *supra* note 9, at 39.

101 UWB First R&O, *supra* note 45, ¶ 271.

102 *Id.* ¶ 18.

103 *See, e.g.*, *id.* ¶ 46 ("[W]e find that imaging systems can be permitted to operate . . . without causing harmful interference" with specified restrictions); *id.* ¶ 64 ("[T]he emission mask we are adopting will prevent harmful interference" from vehicular radar systems); *id.* ¶ 66 ("We are convinced that the conservative emission limits and restrictions we are adopting for UWB indoor devices will prevent harmful interference.").

104 UWB First R&O, *supra* note 45, ¶ 56.

105 *Id.* ¶ 66.

106 *Id.* ¶ 1.

107 *Id.* ¶ 5.

108 *Id.* ¶ 170.

109 *Id.* ¶ 182.

UWB devices causes the *least possible impact* to the authorized radio services"[110] and that the limits are "more than sufficient to prevent harmful interference."[111] In other words, the Commission set a level of permissible interference in many bands that is far, far below any application of the harmful interference standard.

¶58 But how were the individual permissible interference levels set for each band and each UWB application? The Commission explained that:

> The protection levels established in this Order primarily are those determined in the NTIA [National Telecommunications & Information Administration] analyses of Government systems. The UWB emissions level NTIA developed for the GPS bands provides a conservative protection level for all of the government and commercial systems operating between 960 MHz and 1610 MHz.[112]

¶59 In the MVDDS dispute the FCC turned to preexisting unavailability rates to find a level of permissible interference. Here it instead relied on a more conservative government standard in some bands, and set individualized restrictions for other bands without an articulated overarching standard. The government standard is necessarily somewhat opaque.[113] NTIA must try to protect sensitive national security operations. Neither the FCC nor NTIA explained in detail what interference standard it employs for bands important to national security, which, especially in the current security environment, seems wise. The restrictions themselves, in government and other bands, seem to vary with the sensitivity and importance of the incumbent operation, and the physical characteristics of the frequency involved. GPS bands, therefore, have the strictest rules, as GPS is more prone to interference and more critical to public safety and national defense than many other incumbent users.[114] But the FCC did not state clearly that these factors necessarily determined permissible interference.

¶60 An articulated permissible interference standard here would have increased predictability for licensees, equipment manufacturers, government users, and consumers. The Commission even stated that "[t]he analyses and technical standards contained in this Order are unique to this proceeding and will not be considered as a basis for determining or revising standards for other radio frequency devices." Without a standard, and with inconsistent precedent, all we can safely assume is that the Commission will end up somewhere between zero-interference and a difficult-to-predict finding of harmful interference. Such a range of potential outcomes makes industry investment and technical decisions difficult.

C. The Lack of a Permissible Interference Standard Has Real Costs

¶61 The Commission made the MVDDS and UWB determinations without the benefit of a consistent legal standard that articulates the FCC's policy goals and factual considerations when determining permissible interference. It has, however, begun to discuss the concept of permissible interference. For example, the MVDDS Fourth Memorandum Opinion and Order stated that "we note that the Commission's rules, in addition to defining *harmful* interference, also recognize *permissible* interference." FCC rules define "permissible interference" as "[o]bserved or predicted interference which complies with quantitative interference and sharing criteria contained in these [internal Radio] Regulations or in CCIR Recommendations or in special agreements as provided for

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110 *Id.* ¶ 190 (emphasis added).

111 *Id.* ¶ 191.

112 *Id.* ¶ 170. The FCC is an independent commission. The NTIA, on the other hand, is a part of the Department of Commerce and is responsible for developing official telecommunications policy for the government. Part of this responsibility is to coordinate spectrum use for all government agencies, including the Department of Defense. NTIA advocates on behalf of these government agencies in FCC proceedings that affect government spectrum.

113 The Commission states that "[t]he NTIA interference analyses of the effects of RMS and peak power were based on a link budget equation involving the system threshold for interference, as determined using standard established interference protection criteria." *Id.* ¶ 122. It does not explain or define "established interference protection criteria." *Id.*

114 *Id.* ¶ 34.

in these Regulations."[115] This definition, unfortunately, is not particularly useful. It merely suggests that "permissible interference" is any interference allowed by the Commission. It does not provide or suggest how the Commission should go about determining what to allow and what to prohibit.

¶62 A clear, consistently applied standard that articulates the policy goals and factual considerations relevant to determining permissible interference would have created more efficient interference environments and would have reduced uncertainty for potential interferors and potential victims of interference in both the MVDDS and UWB proceedings. More certainty would have benefited licensees, unlicensed operators, unintentional radiators, equipment manufacturers, military, public safety, and scientific spectrum users.

¶63 More generally, uncertainty may lead to under-investment and under-utilization of spectrum resources as future disputes arise. An articulated standard also would strengthen the Commission's hand if it were charged with arbitrary decision making in violation of the Administrative Procedures Act in any future determination of permissible interference.[116]

¶64 Looking further into the future, unless the Commission establishes a workable and consistent permissible interference standard, today's problems may be inherited by a new spectrum management system that uses the interference temperature metric. The next section discusses how to begin the process of creating such a permissible interference standard.

IV. ESTABLISHING A CONSISTENT PERMISSIBLE INTERFERENCE STANDARD

¶65 The Spectrum Policy Task Force Report envisions using the interference temperature metric "to establish maximum permissible levels of interference" in bands throughout the radio spectrum.[117] This plan has the potential to improve U.S. spectrum policy. An analysis of the important MVDDS and UWB proceedings, however, reveals that the Commission does not have an articulated and consistent standard for establishing maximum permissible levels of interference. Even if the Commission adopts the Task Force Report's useful "interference temperature" metric, it will need an improved permissible interference standard to put the metric to work–just as in setting a speed limit the government must not only choose to measure miles per hour instead of kilometers per hour, but also must decide how it will determine whether 45 MPH, 55 MPH or 65 MPH is the permissible speed limit for each road.

¶66 The Commission should initiate a Notice of Inquiry ("NOI") and begin to create an improved permissible interference standard. The goal of this process should be to create a standard specifically designed as a tool for the Commission to use in setting prospective permissible interference levels that maximize the social utility of various spectrum bands, as opposed to a tool for determining retrospectively whether interference has occurred after the Commission receives a complaint. The standard should seek to give potential interferors and interferees a more predictable and understandable interference environment, and to protect the Commission from allegations of arbitrariness.

¶67 In initiating this NOI, the Commission should consider: (1) stating that the purpose of the permissible interference standard is to maximize total utility in each band rather than to minimize interference to any individual spectrum user; (2) recognizing circumstances where private efficiency-enhancing transactions will not correct Commission mistakes in setting incorrect permissible interference temperatures; and (3) addressing the importance of limiting interference in certain

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[115] In 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; 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, Fourth Memorandum Opinion and Order, 18 FCC Rcd. 8428, ¶ 23 n.90 (2003) [hereinafter MVDDS Fourth MO&O]..

[116] 5 U.S.C. § 706 (2002). *See also* Citizens to Preserve Overton Park, Inc. v. Volpe, 401 U.S. 402 (1971).

[117] TASK FORCE REPORT, *supra* note 9, at 28.

critical bands, such as military bands, even if these limitations lead to less intensive use of spectrum resources.

¶68 Setting a single permissible interference temperature for the entire radio spectrum as part of this process is not necessary and would be unwise. RF energy exhibits different physical characteristics at different frequencies and different frequency bands have different interference environments. The alternative to a single temperature, however, is the extremely difficult task of setting individualized temperatures for each band. This second, superior approach is the one envisioned by the Task Force Report.[118] The Commission's struggles to set permissible interference levels in the MVDDS and UWB proceedings demonstrate the difficulties in setting such levels even for individual new services or technologies.[119] Finding a standard that can provide the Commission with a workable decisional tool and spectrum users with predictability across the entire radio spectrum will be a substantial challenge.

¶69 Elements of this challenge were considered by Professor Ronald H. Coase nearly half a century ago. His analysis and recommendations provide the Commission with the basic structure for an improved permissible interference standard. Coase's 1959 article *The Federal Communications Commission*[120] is best known for his suggestion that the Commission use auctions to allocate spectrum property rights instead of comparative hearings to allocate government licenses.[121] In a less-cited portion of that article Coase considers how to resolve spectrum interference disputes.

¶70 According to Coase, there is no analytical difference between the right to protection from interference and the right to cause interference. He explains that "[i]n each case something is denied to others: in one case, use of a resource; in the other, use of a mode of operation."[122] Applying this idea to spectrum policy he goes on to state:

> It is sometimes implied that the aim of regulation in the radio industry should be to minimize interference. But this would be wrong. The aim should be to maximize output. All property rights interfere with the ability of people to use resources. What has to be insured is that the gain from interference more than offsets the harm it produces. There is no reason to suppose that the optimum situation is one in which there is no interference.[123]

¶71 This idea should form the foundation of any permissible interference standard. The Task Force Report recognized the idea that allowing some interference can be a good thing and that a zero-interference policy is inefficient.[124] The Commission's MVDDS and UWB decisions also recognized the inefficiency of a zero-interference right for licensees.[125] Next, the Commission should increase the utility of spectrum resources and predictability for licensees by establishing a well-understood permissible interference standard and explicitly state that the purpose of the standard is not to minimize interference to any individual spectrum user, but to maximize total utility of the band in question.

¶72 The Commission's task would then become how to choose the interference temperature that maximizes total utility. This would have to be accomplished in a band-by-band fashion, taking the

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118 *Id.* .

119 *See supra* Part II.

120 R. H. Coase, *The Federal Communications Commission*, 2 J.L. & ECON. 1 (1959).

121 *Id.* at 17-24. The Commission now allocates spectrum rights by auction in many instances, although it does not grant property rights for spectrum use. The question of whether spectrum users should be granted property rights has been written on extensively and is beyond the scope of this article. *See, e.g.*, Stuart Buck, *Replacing Spectrum Auctions with a Spectrum Commons*, 2002 STAN. TECH. L. REV. 2; Thomas W. Hazlett, *The Wireless Craze, The Unlimited Bandwidth Myth, The Spectum Auction Faux Pas, and the Punchline to Ronald Coase's "Big Joke": An Essay on Airwave Allocation Policy*, 14 HARV. J.L. & TECH. 335 (2001).

122 Coase, *supra* note 121, at 26.

123 *Id.* at 27.

124 TASK FORCE REPORT, *supra* note 9, at 25-35.

125 *See supra* Part II.

physical characteristics of energy in the band and the nature of the spectrum users in question into account.[126] Developing a predictable and non-arbitrary method of setting the temperature for different bands could be accomplished through the NOI once this basic goal of the permissible interference standard is made clear. There will be no one-size-fits-all solution, and establishing a discrete set of considerations for the Commission that are consistent, non-arbitrary, and well understood will be the heavy-lifting portion of the NOI.

¶73 As part of this process the Commission should recognize that in certain situations its determination of permissible interference will be more critical than others. Once the permissible interference temperature is known in a band where there are a small number of identifiable spectrum users, Coase's argument suggests that the parties can enter into private transactions that result in an efficient amount of interference–meaning a level of interference that maximizes the combined values of the parties' use of the band in question–even if the Commission sets an inefficient interference temperature.[127] This is because, theoretically, if the interferee experiences interference above the permissible temperature, it can identify the source of the interference and petition the Commission to stop the interferor's activities. To convince the interferee not to complain to the Commission, the interferor would then be willing to pay the interferee an amount up to the interferor's cost of complying with the temperature, plus the reduced value of its use of the spectrum while complying. If this amount is more than either the interferee's cost of protecting itself from the higher temperature or the reduced value of the spectrum to the interferee in this interference environment, the interferee will take the money and not complain to the Commission. That would mean that the Commission had chosen a temperature that was too low. But the transaction would fix this mistake. The post-transaction level of interference would theoretically rise to a level that maximizes overall economic value.

¶74 If the interferee experiences interference below the permissible temperature, it can not petition the Commission to stop the interferor's activities. The interferee would then be willing to pay the interferor an amount up to its cost of protecting itself from the interference or the reduced value of its use of the spectrum while experiencing the interference to reduce the interference level. If this payment is more than either the interferor's cost of reducing interference to a level acceptable to the interferee plus its reduced value of using the spectrum while complying with this level, the interferor will take the money. That would mean that the Commission had set too high a temperature. But again the transaction would fix this mistake. The post-transaction level of interference would theoretically sink to a level that maximizes overall utility.

¶75 A world where the Commission's initial interference temperature decisions do not matter will not, however, necessarily exist. In many circumstances the FCC's initial determination of permissible interference temperature will have a great impact because efficient transactions between spectrum users may not occur to fix the Commission's mistake. For example, an incumbent spectrum user may be willing to forgo an overall efficient transaction like the one described above in order to deny a potential competitor access to spectrum. If the cost of competing with an additional company is high enough, especially if the new competitor is using a new and superior technology that could drive the interferee from the market, the incumbent will not accept payment at a level that would maximize overall efficiency.

¶76 Additionally, as Professor Coase recognizes:

> When the transfer of rights has to come about as a result of market transactions carried out

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[126] I note here again that the Commission could instead propertize spectrum rights and allow owners to sell access, thereby allowing private parties to set permissible interference by negotiation. The wisdom of this approach, and the significant regulatory changes needed to implement it, are beyond the scope of this article. This article assumes that the FCC's current rejection of the no-interference rule advocated by Sprint in the UWB proceeding and practically advocated by DBS providers in the MVDDS proceeding is in place.

[127] *See* Coase, *supra* note 121, at 28-29. Coase's treatment of interference policy is based on a system where spectrum users have property rights. Although today's spectrum users do not have property rights, his analysis remains useful in setting permissible interference temperatures that give spectrum licensees the ability to petition the Commission for interference protection rather than seek judicial action to enforce an element of a property right.

> between large numbers of people or organizations acting jointly, the process of negotiation may be so difficult and time-consuming as to make such transfers a practical impossibility.[128]

¶77 When there are many potential interferors and interferees in a band, the costs of identifying the spectrum user causing interference, or transacting with a multitude of interferees in a crowded band, may be high enough that efficient transactions do not occur. This could well be true where unlicensed operation permits thousands of different commercial products to emit energy in various bands.

¶78 Furthermore, certain technologies can cause interference across many bands. With many bands, and therefore many licensees, affected by a single interferor, the number of transactions needed to permit efficient operation could quickly grow to a number that is so high that efficient transactions will not occur because of transaction costs. This could well be true in the UWB context. Coase, with admirable foresight, recognizes the challenge posed by wideband technologies, noting that "the need for wide bands of frequencies for certain purposes may require the exercise of the power of eminent domain" by the government.[129]

¶79 Therefore, while the Commission should always seek to set an interference temperature so that the overall use of the band is maximized, an incorrect choice of temperature may be correctable by market transactions when a band is occupied by a small number of known operators, and these operators are not competitors. But, where anti-competitive behavior, large numbers of potential interferors and interferees, or wideband technologies are involved, the Commission's choice of permissible interference temperature may not be easily correctable by private transactions, and, therefore, becomes particularly important.

¶80 Finally, it is critical that the permissible interference standard recognize the importance of limiting interference in certain socially critical bands even if limitations lead to a less intensive use of these bands. The Commission's goal should still be to maximize total social utility in these bands, but in bands occupied by users such as the military, radio astronomers, public safety entities, and educators, utility is not easily measurable in dollars. The hard-to-measure value of these spectrum users should not lead the Commission to establish permissible interference temperatures that result in interference environments that undermine these important activities. In gauging utility the Commission often falls victim to the tyranny of the quantifiable. Doing so here could lead to great damage.

¶81 This does not mean, however, that the Commission should set permissible interference levels that aim at zero interference in these bands. The FCC and the NTIA should jointly establish policies that seek to increase efficiency and to promote intensive use of the spectrum used by these entities. As hard as the project may be, the FCC's permissible interference standard should state how it will balance hard-to-quantify values of national defense, scientific progress, public safety, and education with economic growth through more intensive use of spectrum resources. To do otherwise will cause unpredictability for these critical users as well as for commercial users, and will slow any future proceeding where these bands are at issue.

V. CONCLUSION

¶82 Spectrum policy has taken center stage at the Commission. Fundamental changes in the way the United States regulates wireless devices and services have begun. Correctly setting permissible levels of interference in new band plans and for new technologies is central to improving spectrum policy.

¶83 However, the Commission does not have an adequate and consistent standard for setting permissible interference levels. Without such a standard, divisive disputes, such as those seen in the MVDDS and UWB proceedings, will continue to create unpredictability, and require the

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[128] Coase, *supra* note 121, at 29.

[129] *Id.* at 30.

Commission to expend tremendous resources to set interference levels that may not be efficient and that invite charges of arbitrariness. This would lead to underinvestment, slower economic growth, and litigation, and would threaten to undermine the potentially very useful concepts contained in the Spectrum Policy Task Force Report.

¶84 The Commission should therefore initiate a NOI to establish a better standard for setting permissible levels of interference. The goal of this standard should be to set interference levels that maximize total social utility in a band, rather than minimize interference for any individual licensee. The standard should also recognize that while private transactions may correct Commission mistakes in setting interference temperatures in some circumstances, they will not always do so. Where spectrum users are potential competitors, and where potential interferees and interferors are numerous, efficiency-enhancing transactions may not occur, making initial FCC decisions much more important. Finally, the Commission should recognize the special challenges posed where interference may occur to military, scientific, public safety, and educational users. In doing so, it should establish procedures to account for the hard-to-quantify benefits of these activities when setting permissible interference levels.