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

In the Matter of	)	
	)	
Issues Related to the Commission's	)	ET Docket No. 02-135
Spectrum Policies	)	

To: The Spectrum Policy Task Force

COMMENTS OF SPRINT CORPORATION

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Table of Contents

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	)	
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Sprint Corporation ("Sprint") submits these comments in response to the Spectrum Policy Task Force's ("Task Force") invitation for recommendations to improve the Commission's spectrum policies.[1] Sprint Spectrum L.P., d/b/a Sprint PCS ("Sprint PCS") operates a nationwide, state-of-the-art broadband PCS network. Sprint also provides fixed wireless broadband service over owned and leased Multipoint Distribution Service and Multichannel Multipoint Distribution Service (collectively "MDS") and Instructional Television Fixed Service channels ("ITFS") in multiple markets in the United States.

I. INTRODUCTION AND SUMMARY

This nation has radically changed the way it has managed spectrum over the past decade, moving from a government-based command-and-control approach to a market-oriented policy for spectrum management. This change began nearly a decade ago, when Congress authorized (and later required) the Commission to auction spectrum when mutually exclusive applications are filed, with Congress determining that "[a]uctions . . . ensure that licenses are assigned to the

[1] *See Public Notice*, "Spectrum Policy Task Force Seeks Public Comment on Issues Related to Commission's Spectrum Policies," ET Docket 02-135, DA 02-1311 (June 6, 2002)("*Spectrum Policy Notice*").

entity that most values the frequencies."[2] This change took another important step when, beginning with PCS service rules, the Commission began giving licensees flexibility to provide the services the public demands. Thus, unlike their European counterparts, which are rigidly required by government fiat to provide specified services in specified bands using specified technologies, U.S. CMRS licensees are free to provide in their frequency bands any fixed or mobile telecommunications service using any technology.

The market-oriented policies that the Commission has begun to implement have been enormously successful. Consider the market for mobile telephony services. In the six years since Sprint and other PCS licensees have entered the market:

- The number of mobile customers has nearly quadrupled, from 33.8 million in December 1995 to 128.4 million in December 2001;[3]
- The average price per minute has fallen by over 70%, from 43 cents in 1995 to 12 cents in 2001;[4]
- Average monthly usage per customer has tripled, from 119 minutes in 1995 to 385 minutes in 2001;[5]
- Four of five Americans have a choice of five or more mobile service providers;[6] and
- All but three percent of Americans have access to some type of digital service.[7]

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[2] H.R. Rep. No. 105-149, 105th Cong., 1st Sess. 558 (June 24, 1997). *See also Amendment of Section 2.106 of the Commission's Rules to Allocate Spectrum at 2 GHz for Use by the Mobile-Satellite Service*, Notice of Proposed Rulemaking, 10 FCC Rcd 3230, 3233 ¶ 17 (1995)("[C]ompetitive bidding best serves the public interest by ensuring that the licenses are awarded to the entities that value them the most highly."); *Second Competitive Bidding Order*, 9 FCC Rcd 2348, 2361 ¶ 71 (1994)("Since a bidder's abilities to introduce valuable new services and to deploy them quickly, intensively, and efficiently increases the value of a license to a bidder, an auction design that awards licenses to those bidders with the highest willingness to pay tends to promote the development and rapid deployment of new services in each area and the efficient and intensive use of spectrum.").

[3] *See Seventh Annual CMRS Competition Report*, FCC 02-179, Appendix C, Table 1 (rel. July 3, 2002) ("*Seventh CMRS Competition Report*").

[4] *See id.* at Appendix C, Table 9.

[5] *See id.*

[6] *See id.* at Table 5.

Mobile service, once seen as a luxury service used by a few, has become an indispensable tool in our daily lives, with 58% of all Americans 12 and older subscribing to the service.[8]

It is the nascent mobile data market that the Commission's market-oriented policies may affect most profoundly. Some carriers have already activated their "third generation" networks in selected markets; Sprint PCS will be activating nationwide its 3G network later this summer. Although 3G network activation is just beginning, mobile Internet access at speeds comparable to landline 56 kbps dialup modem service is already available to nearly 63% of all Americans.[9] The Commission noted last week that "[c]ompetition continues to be an integral part in shaping the mobile data sector":

> A multitude of dynamic mobile data service packages, and pricing plans are [becoming] available to consumers from a variety of providers, including mobile telephone carriers, paging carriers, and handheld device providers.[10]

3G networks are important because they will provide new capabilities to the American public, allowing them to enjoy new applications that will enhance the quality of their daily lives as well as improve productivity, thereby reinvigorating our nation's economy. However, 3G networks (and further technical developments) are also important to the Commission's spectrum management policies, because advanced wireless technologies enable licensees to use their spectrum more efficiently. For example, the first phase of Sprint's 3G network, 1xRTT, will include the following capabilities using the same amount of spectrum consumed by 2G technologies:

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[7] *See id.* at Table 7.

[8] *See id.* at 32. Although the European Union has a higher penetration rate (74% vs. 45% in the U.S.), U.S. customers use their handset far more often (338 MOU vs. 130 MOU in E.U.) and in terms of revenue per minute, pay on average about 25 percent less than E.U. customers. *Id*. at 48-53.

[9] *See id.*at 55.

[10] *Id.* at 82.

- Maximum data transmission rates will increase tenfold, from 14 kbps to 144 kbps, with average data speeds around 50-70 kbps;
- Capacity for voice traffic will nearly double, creating room for data traffic and additional voice customers;
- Improved management of power resources, resulting in a doubling of a handset's battery life; and
- An "always-on," always-connected capability.

Later phases of Sprint's 3G network deployment are expected to achieve even greater spectrum efficiencies and more robust capabilities for consumers.

These kinds of technical advances are enormously important to consumers, to our nation's economy, and to the "efficient and intensive use of [scarce] electromagnetic spectrum."[11] But as Sprint discusses below, 3G and future networks are based on three critical licensee rights: the licensee has exclusive use of its spectrum; the licensee will be protected from harmful interference; and the licensee will have a renewal expectancy for continued use of the spectrum for the future. The Commission must act to confirm these core rights.

Chairman Powell has recognized that in implementing a market-oriented spectrum policy, it is "vital" that the Commission "clearly define spectrum interference limits and usage rights."[12] Sprint wholeheartedly agrees with this observation. Sprint therefore focuses in these comments on the two issues that the Chairman has identified – spectrum usage rights and protection from harmful interference – because as the Chairman correctly recognizes, Commission clarification in these two areas will best facilitate the completion of the transition to a market-oriented spectrum management policy. Market-oriented spectrum policy and Commission confirmation of predictable and reliable license rights will promote rational capital allocation and service innovation and efficiency.

[11] 47 U.S.C. § 309(j)(3)(D).

In Part II below, Sprint identifies the basic set of spectrum rights that the Commission should confirm are possessed by each licensee of non-shared spectrum, including the core rights of exclusivity, protection from harmful interference, and a renewal expectancy. Sprint further encourages the Commission to complete its *Secondary Market* rulemaking, because the secondary market for spectrum offers an important opportunity to further improve the efficiency with which scarce spectrum is being used. However, and of importance, the secondary market will never reach its full potential unless the Commission confirms the core set of rights licensees possess in their assigned frequencies.

In Part III, Sprint discusses the definition of harmful interference. The current rule was adopted 40 years ago and is inadequate for modern wireless technologies that have been developed since then. The need to protect incumbent licensees against harmful interference is a core Commission responsibility, and the Commission must confirm this protection and update its definition of harmful interference to account for modern technologies and circumstances. In this filing, Sprint identifies deficiencies with the current definition. The Commission should act to refine the definition to appropriately account for modern wireless technologies and the implementation of a market-oriented spectrum policy.

In Part IV, Sprint discusses the subject of spectrum efficiency in the context of the Commission's recent trend to encourage greater sharing of the same spectrum bands. Sprint demonstrates that in certain circumstances, spectrum sharing can actually ***undermine*** the efficiency with which spectrum is utilized because spectrum sharing can inhibit incumbent licensees from taking advantage of more spectrally efficient technologies. Accordingly, in considering new proposals

[12] Chairman Michael K. Powell, "Digital Broadband Migration, Part II" (Oct. 23, 2001).

to share certain spectrum, the Commission must concurrently examine the efficiency losses and operational impacts to existing licensees.

II. THE COMMISSION'S SPECTRUM POLICIES MUST RECOGNIZE THE SPECTRUM USAGE RIGHTS HELD BY LICENSEES AND THE CONSEQUENCES OF MODIFYING THESE RIGHTS FOR LICENSES ACQUIRED AT AUCTION

One of the two most important steps the Commission can take to further the transition to a market-oriented spectrum management policy and to encourage investment in new, spectrally-efficient technologies is to clarify and confirm the spectrum usage rights possessed by radio licensees.

A. The Commission Should Confirm the Spectrum Usage Rights Possessed by Licensees in Order to Facilitate the Transition to a Market-Oriented Spectrum Policy and Ensure Investment and Efficient Spectrum Use

At first blush one might conclude that licensees have no rights in their assigned frequencies because the Communications Act states that radio licenses do not have an ownership interest in their assigned frequencies.[13] Courts and the Commission have in fact held otherwise, and Commission confirmation of this essential fact is most critical.

Courts recognized only five years following the enactment of the Communications Act that "the Act does definitely recognize the *rights* of license holders in express terms no less than seven times":

> [T]he granting of a license by the Commission creates a highly valuable property right, which, while limited in character, nevertheless provides the basis upon which large investments of capital are made and large commercial enterprises are conducted. As it is the purpose of the Act to secure the use of the channels of radio communications by private licenses under a competitive system, those licensees must be protected in that use, not merely from unlicensed stations and unlicensed operators, but from improper activities of licensed stations and operators,

[13] *See* 47 U.S.C. § 301 ("It is the purpose of this chapter . . . to provide for the use of such [radio] channels, but not the ownership thereof . . . .").

> and from arbitrary action by the Commission, itself, in the exercise of its regulatory power.[14]

Courts have specifically recognized that a radio license entails a "vested interest":[15]

> [N]either is [a license] a non-protected interest, defeasible at will. Indeed, to suggest as much would, among other things, throw considerable doubt on the Commission's well-known recognition of a renewal expectancy that leads applicants to vie for licenses which, if awarded, will require a significant expenditure of resources.[16]

The Commission, too, has recognized that a radio license "confers on the licensee certain spectrum usage rights."[17] More explicitly, it has declared that licensees must have "certain rights and responsibilities *that define and ensure their economic interests.*"[18] Sprint has invested billions of dollars in spectrum acquisition and network deployment based on the reasonable reliance interests derived from its Commission-issued licenses. For example, Sprint has spent $3 billion to acquire PCS licenses and over $12 billion to construct a state-of-the-art CDMA network. In addition, Sprint spent more than $1.2 billion in the secondary market to acquire rights to MDS and ITFS spectrum necessary to develop its two-way broadband service and approximately $1 billion more to staff, organize and begin rolling out its operations. Sprint's willingness to ex-

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[14] *Yankee Network* v. *FCC,* 107 F.2d 212, 216-17 (D.C. Cir. 1939)(emphasis in original). *See also L.B. Wilson* v. *FCC,* 170 F.2d 793, 798 (D.C. Cir. 1948)("A [radio] license is a thing of value to the person to whom it is issued and a business conducted under it may be the subject of injury. . . . [P]rovisions of the Communications Act itself . . . recognize that a broadcasting license confers a private right, although a limited and defeasible one."); *In Re Atlantic Business and Community Development Corp.,* 994 F.2d 1069, 1074 (3d Cir. 1993)("The Communications Act itself seems to imply the existence of a limited property right in the FCC license one it is granted. Section 301 . . . implies the creation of rights akin to those created by a property interest limited only by the 'terms, conditions and periods of the license.'").

[15] *Reuters Ltd.* v. *FCC,* 781 F.2d 946, 950 n.5 (D.C. Cir. 1986).

[16] *Orange Park Florida* v. *FCC,* 811 F.2d 664, 674 n.19 (D.C. Cir. 1987).

[17] *Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets,* Notice of Proposed Rulemaking, 15 FCC Rcd 24,203, 24,208 ¶ 12 (2000) (*Secondary Markets NPRM*).

[18] *Principles for Promoting the Efficient Use of Spectrum by Encouraging the Development of Secondary Markets,* Policy Statement, 15 FCC Rcd 24,178, 24,186 ¶ 20 (2000) (emphasis added) (*Secondary Markets Policy Statement*).

pend billions of dollars was based in large part on the rights that are part of a Commission license. Indeed, the *Spectrum Policy Notice* repeatedly refers to the "rights" of incumbent licensees.[19]

The Commission, recognizing that "clarifying a licensee's spectrum usage rights will facilitate markets,"[20] has articulated several principles that it "intend[s] to apply . . . concerning licensee rights," including "clearly defined usage rights to their spectrum" and "the right to be protected from interference."[21] A market-oriented approach to spectrum management will not develop further until the Commission clarifies the nature of spectrum usage rights. Sprint therefore asks the Commission to confirm that, at minimum, all licensees (other than those sharing the same frequency band) possess the following rights:

- The right to exclusivity. For example, the Commission itself recently confirmed that PCS licensees possess an "exclusive right to the [PCS] spectrum" and involve "exclusive licensing arrangements":

  > Under FCC licenses, performances are owned by both the licensee and the FCC. While [a PCS licensee] must obey FCC rules and make the required [auction] payments, the FCC must protect [the PCS licensee's] exclusive right to the spectrum and refrain from authorizing others to use that spectrum.[22]

  Exclusivity rights are essential to a market-oriented approach to spectrum management, because exclusivity will continue to encourage businesses to invest in technologies to use the spectrum most intensively. Exclusivity is also important because new technologies that achieve greater spectrum efficiency are often more sensitive to interference of other spectrum uses.
- The right to protection from all harmful interference. Sprint discusses this subject more fully in Part III below; and
- The right to a renewal expectancy. Like exclusivity, renewal expectancy is critical to a market-oriented approach to spectrum management because firms will

[19] *Spectrum Policy Notice* at 2 and 4.

[20] *Secondary Markets Policy Statement*, 15 FCC Rcd 24178, 24187 ¶ 22.

[21] *Id.* at 24186 ¶ 20.

[22] FCC Brief, *FCC* v. *NextWave Personal Communications,* Nos. 01-653 and 01-657, at 34 n.10 (U.S., filed May 6, 2002).

> have no incentive to make massive investments in spectrally efficient technologies without a renewal expectancy. As the Commission has recognized, a "high renewal expectancy will provide a stable environment that is conducive to investment, and thereby will foster the rapid deployment of PCS."[23] MDS licensees have been provided a similar renewal expectancy for the same reasons.[24]

Of course, the Commission can also use this process to similarly confirm the obligations of licensees, including the obligation to make timely payments (for auctioned licenses), the obligation to meet buildout requirements in a timely manner, and the obligation to comply with Commission rules.

Sprint also encourages the Commission to complete promptly its *Secondary Markets* rulemaking, so as to facilitate the ability of licensees to transfer or lease their spectrum usage rights.[25] As noted above, Sprint has invested $1.2 billion in the secondary market to acquire rights to MDS licenses and leased rights to MDS and ITFS licenses for wireless broadband services. The Commission has correctly noted, however, that a broad, comprehensive secondary market "remains underdeveloped."[26] Licensees are in a far better position than a regulatory agency to gauge whether assigned spectrum can be used more intensively or efficiently, while retaining ultimate authority over the decision to lease or transfer spectrum usage rights. Nevertheless, the fact remains that a robust secondary market will never reach its full potential so long as the Commission applies the control standard it adopted in the 1963 *Intermountain Microwave* decision.[27] That 39 year-old standard fails to account for the fundamental changes that have oc-

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[23] *Second PCS Order*, 8 FCC Rcd 7700, 7763 ¶ 131 (1993).

[24] *See Amendment of Parts 21 and 74 of the Commission's Rules With Regard to Filing Procedures in the Multipoint Distribution Service and in the Instructional Television Fixed Service*, 10 FCC Rcd 13821 (1995).

[25] *See Secondary Markets NPRM*, 15 FCC Rcd 24203.

[26] *Secondary Markets Policy Statement*, 15 FCC Rcd at 24178 ¶ 2 and 24184 ¶ 15.

[27] *See Intermountain Microwave*, 24 Rad. Reg. (P&F) 983 (1963).

curred in technology and the marketplace or for the new policy of market-oriented spectrum management.[28]

B. Sound Spectrum Management Policy Must Take Into Account the Financial Consequences to the Government of Modifying Licenses Acquired at Auction

The Communications Act empowers the Commission to modify a radio license under specified circumstances. The right to modify licenses applies both to licenses acquired for free and to licenses acquired at auction – so long as the Commission complies with the procedures specified in the Administrative Procedures Act and the Communications Act.[29] However, there can be financial consequences to the government if the Commission curtails the rights of incumbent licensees who obtained their licenses at auction.

With licenses acquired at auction, the government receives valuable consideration in return for the license grant and the receipt of this consideration forms a contract between the licensee and the government.[30] The Commission has recognized that consideration for a valid government contract, including an implied-in-fact contract, "must render a benefit to the government."[31] The government certainly received a valuable (and sizable) benefit by issuing PCS licenses; as noted above, Sprint alone paid the government over $3 billion for its PCS licenses.

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[28] Indeed, the Commission has promoted an active secondary market for the leasing of excess Instructional Television Fixed Service capacity (most licensees lease excess capacity to Sprint or others for commercial operations) in large part by approving spectrum leases that depart from a strict reading of *Intermountain Microwave* but which otherwise assure compliance with Section 310(d) of the Communications Act. *See "Spectrum Study of the 2500-2690 MHz Band – the Potential for Accommodating Third Generation Mobile Systems,"* Final Report, at 18 (rel. Mar. 30, 2001).

[29] *See, e.g.,* 47 U.S.C. § 316.

[30] The government may also face damages liability if a licensee detrimentally relied on Commission action, even in the absence of consideration. For example, Sprint invested billions of dollars to clear its PCS spectrum and to construct its nationwide, state-of-the-art CDMA network.

[31] *Certain Cellular Rural Service Area Applications,* Memorandum Opinion and Order, FCC 02-129, at ¶ 14 (rel. May 9, 2002)(internal citations omitted).

The Commission has already acknowledged that PCS licenses at minimum constitute executory contracts.[32] The Supreme Court has held that the government is liable for breach of contract, even when the contracting agency is prevented from honoring its bargain as a result of subsequent Congressional enactments.[33]

To confirm, Sprint does not question the Commission's legal authority to modify licenses. Nevertheless, modification of licenses acquired at auction will expose the federal government to damages liability for the harm a licensee incurs as a result of a license modification and contract breach. Obviously, the Commission's spectrum management policies should account for this contingency. Importantly, the Commission should generally be cautious in modifying incumbent licenses; such action introduces administrative uncertainty that can negatively impact confidence in the regulatory process and negatively impact investment and spectrum efficiency.

III. THE 40-YEAR-OLD DEFINITION OF HARMFUL INTERFERENCE SHOULD BE UPDATED TO REFLECT TECHNOLOGICAL ADVANCES AND A MARKET-ORIENTED SPECTRUM POLICY

The second of the two most important steps the Commission can take regarding its spectrum management policies is to revise and update its definition of harmful interference to account for modern communications technologies and a market-oriented spectrum policy.

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[32] *See* FCC Brief, *FCC* v. *NextWave Personal Communications,* Nos. 01-653 and 01-657, at 34 n.10 (U.S., filed May 6, 2002). The contracts in question are for the right to access and use the spectrum, not for an ownership interest in certain frequencies. *See* note 13 *supra.*

[33] *See, e.g., Mobil Oil* v. *United States,* 530 U.S. 604 (2000)(Department of Interior breached oil lease contracts even though breach was caused by subsequent act of Congress); *United States* v. *Winstar,* 518 U.S. 839 (1996)(Government contractually liable for damages which arose when Congress amended the law, so as to deny certain savings and loans regulatory treatment to which the government had contractually committed itself); *see also Hughes Communications* v. *United States,* 998 F.2d 953 (Fed. Cir. 1993) (NASA financially responsible to satellite company for changes in policy triggered by sovereign government action).

"Among the Commission's core responsibilities is that of ensuring avoidance of harmful interference among spectrum users."[34] Indeed, the Commission's predecessor, the Federal Radio Commission, was established precisely to manage the radio spectrum so as to avoid harmful interference. The Supreme Court has noted the "confusion and chaos" prior to the enactment of the Radio Act of 1927 and the establishment of rules governing harmful interference:

> With everybody on the air, nobody could be heard. The situation became so intolerable that the President in his message of December 7, 1926, appealed to Congress to enact a comprehensive radio law.[35]

The Commission has correctly acknowledged that protection from harmful interference becomes "more important with more intensive use of the radio spectrum."[36] As demonstrated below, protection from harmful interference becomes even more important if the Commission expects licensees to introduce even more spectrally efficient technologies such as 3G.

The Commission asks whether a new definition of harmful interference is needed or whether more explicit protections from harmful interference of incumbent users are required.[37] There can be no serious dispute over the need for the Commission to confirm and clarify the scope of harmful interference, if not codify those clarifications in the rules or in notes to the rules. The current definition of harmful interference was adopted 40 years ago,[38] and that defini-

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[34] *Secondary Markets NPRM,* 15 FCC Rcd 24203, 24233 ¶ 84 (2000). *See also Policies and Rules Regarding AM Radio Service,* MM Docket No. 93-177, RM-7594, at ¶ 7 (June 11, 1999)("Prevention of interference . . . remains a core regulatory function of this Commission."); *Courtesy Communications,* 14 FCC Rcd 4198, 4201 ¶ 7 (1999)("[A]voidance of harmful interference between users is one of the core purposes of our spectrum management duties.").

[35] *NBC* v. *FCC,* 319 U.S. 190, 212 (1943).

[36] *Spectrum Policy Notice* at 3.

[37] *See id.* at 4, Question Nos. 7 and 9.

[38] *See Amendment of Part 9,* 42 F.C.C. 1147 (1962).

tion is largely the same as the Commission utilized at least as early as 1948.[39] The enormous technological changes that have occurred over the past half-century and the sheer number of radio devices in the market today are reasons alone to update the definition of harmful interference.[40] In addition, a definition adopted in the days when spectrum management policies were based on government command-and-control is not conducive to a market-oriented environment.

Commission rules define "harmful interference" as "[i]nterference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with these [international] Radio Regulations."[41] There are several major weaknesses in this definition, based on current circumstances and technological developments.

- First, the current definition is highly subjective and as a result, open to a broad range of interpretations. For example, what qualifies as "serious" degradation is not defined and can be subject to *ad hoc* interpretations.

- Second, the definition is obsolete, as it appears to be intended for a situation in which a service is compromised by one or a small number of radio transmitters that have an identifiable effect on the primary service. However, the Commission often uses its definition of "harmful interference" as a criterion to determine whether an additional service should be allowed to coexist in the same band as an existing service, or whether a low-power (often unlicensed) application can share spectrum on a secondary basis with a licensed incumbent. In these cases, the effect on

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[39] *See Amendment of Part 2,* 39 F.C.C. 346 (1948).

[40] At the time the Commission developed its current definition, most radio services in existence were one-way services (*e.g.*, radio and TV broadcasting, paging) that used a small number of transmitters. Today, there are millions of radio transmitters in the market, including CMRS handsets and laptops/PDAs equipped to use 802.11 networks.

[41] 47 C.F.R. § 2.1(c).

the existing service may be subtle and difficult to identify (*e.g.*, a gradual increase in the effective average noise floor), and may result from a proliferation of many devices transmitting at random times from random locations. In considering interference protection, it is therefore important for the Commission to be mindful of the fact that degradation may be incremental and that the more devices that are overlaid on an incumbent service, the greater the degradation will be. Given the dramatic proliferation in the number of radio transmitters, many of which are mobile, it is time for the Commission to assess the cumulative effect of the emissions from these devices.

- Third, the definition does not take into account the adaptive capabilities used by many modern communications systems. The definition uses "obstruction" and "repeated interruption" as criteria. However, many of today's communications systems are adaptive, in that they can adjust parameters such as transmit power and data rate to compensate for the condition of the communication channel, including path loss and interference at the receiver. For example, the IS-95 code-division multiple access ("CDMA") air interface used in PCS and cellular networks uses transmit power control on both uplink and downlink transmissions. Power control is designed to adaptively adjust the transmit power such that the received signal power at the other end of the link is just adequate to achieve the desired frame error rate. If the interference at the receiver is increased, the transmitter will increase its power output to compensate – up to a limit. The link is thereby maintained in the presence of added interference and, therefore, may not be "obstructed" or "interrupted," but there is a cost to total system capacity.[42] Coverage is also

[42] For example, for the CDMA systems used by Sprint PCS, the mechanism for the loss in capacity is different on the uplink and downlink. On the downlink, for example, the total maximum power transmitted by the base station for each sector is limited. The total transmit power is divided (allocated) among the active handsets in the sector. If more power must be allocated to a particular handset to compensate

compromised, because in locations that are marginal without the added interference, the additional power needed to compensate for interference may not be available.

- Fourth, the current definition of harmful interference is too general to be useful for a particular service. The specific definition of what constitutes "harmful interference" should depend on the nature of the victim service and the function it is intended to serve. For example, in the case of a geolocation service such as GPS, the intended function is to provide accurate location information. Thus, "harmful interference" might best be defined in terms of a degradation in location accuracy. In the case of CMRS, the intended function is to provide wireless connectivity to subscribers with a high probability that service is available within the nominal coverage area. Thus, for CMRS, the effect of added interference will be to increase the probability that service is unavailable (*i.e.*, increased probability of an outage), which will result in increased call blocking and dropped connections.

- Fifth, the Commission should confirm that harmful interference impacts must be evaluated based on the situation as it existed at the time the license was awarded, not at some later date after networks have been constructed. In this regard, the Commission has previously recognized that spectrum usage rights must be determined "at the time of [license] issuance."[43] Wireless network designs, including such factors as link budget and interference margins, are based on conditions that existed at the time the spectrum was acquired. For existing radio sys-

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for added interference, less power is available for other handsets, which translates to a net capacity reduction.

An alternative to power control is data rate adaptation, as is used by the wireless local area network ("WLAN") standards IEEE 802.11(a) and (b). This is based on the principle that the lower the data rate (bits per second) the lower the required signal-to-interference plus noise ratio ("SINR"). If the SINR at a given receiving node is reduced, either due to increased path loss from the transmitter or increased interference, the data rate is reduced to compensate. While the link is maintained, throughput is reduced.

[43] *Secondary Markets Policy Statement*, 15 FCC Rcd at 24187 ¶ 22.

tems, once infrastructure is deployed, subsequent modification to compensate for added external interference is expensive at best, and often totally impractical. Base station siting and construction is time-consuming and expensive, and adding or relocating base stations (to adjust for new harmful interference) is not always feasible.[44] The alternative, increasing transmitted power, would require replacing the power amplifiers in the base stations for the downlink, and replacing all the handsets for the uplink. Neither option is economically viable. Certainly, no licensee operating on a primary basis should be responsible to take such action.

Accordingly, the Commission must carefully evaluate, *a priori*, the interference impact of any proposed sharing or overlay scenario. The stakes are simply too high, and after-the-fact, *ad hoc* remedies, such as modifying or discontinuing individual interfering transmissions, are simply not feasible in many modern overlay or sharing scenarios. Moreover, for a situation in which an overlay of many low-power unlicensed transmitters is proposed, as in the case of ultra-wideband ("UWB"), exhaustive testing, even in advance of deployment, may be impractical and the interference impact must be determined by analysis, with some limited testing to verify system behavior and confirm key parameters. Proponents of a proposed new service, which have the burden of demonstrating the absence of harmful interference on existing licensees,[45] should

[44] For example, new harmful interference may adversely affect the ability of a licensee to provide adequate service at the cell edges. It might not be cost effective to deploy costly new cell sites at the edges of existing cells, even assuming suitable sites can be located and approved by the local authorities. Even if a new cell site can be obtained and cost justified, it takes over 18 months on average to deploy a new cell site. Thus, customers that had been accustomed to receiving service in a particular area will suddenly encounter a new gap in service that may not be fixed for some time. And the customer will likely not realize that external devices are causing the harmful impacts to service reception.

[45] *See, e.g., Cosmopolitan Enterprises*, 15 F.C.C.2d 659, 674 No. 4 (1967)("The burden of proof is on the applicants and unless it has been shown affirmatively that either or both of the proposed antenna systems will function without the hazard of interference, the burden has not been sustained."). *See also AirCell*, 15 FCC Rcd 9622, 9629 ¶ 18 (2000)("AirCell was required to make an affirmative showing that its system is not likely to cause harmful interference to terrestrial cellular operations."); *New Channels Communications*, 57 R.R.2d 1600 ¶ 6 (1985).

be obligated to provide the equipment samples and expertise necessary to support the testing and analysis. Clearly, however, incumbent licensees must be involved as well, because they have the expertise necessary to support the analysis of interference effects on their systems.

- Finally, the Commission should address a potential problem with a "harmful interference" threshold. If such a threshold is applied on a case-by-case basis, using *existing* conditions as a baseline, the effects of interference from multiple overlays or coexisting systems will add, and the net impact on unavailability will exceed the threshold, using the *original* system design criteria as a baseline. One way to address this problem is for the Commission to apply a cap to the total interference effect from all overlaid or coexisting systems. Once the interference effect reaches the cap, no more secondary devices or systems would be authorized to share the affected band.

IV. SPECTRUM-SHARING AND OVERLAYS CAN REDUCE THE SPECTRUM EFFICIENCY OF SPECTRUM-EFFICIENT INCUMBENT SERVICES AND THE COMMISSION MUST NOT ACT TO UNDERMINE SUCH EFFICIENCIES

Spectrum efficiency is clearly an area of major interest to the Commission, as evidenced by the series of questions posed in the *Spectrum Policy Notice*.[46] Two mechanisms by which spectrum efficiency can be increased are: (1) evolution of air interfaces to exploit the most advanced radio communications technology; and (2) the sharing of spectrum among compatible services. However, as demonstrated below, there can be tradeoffs, and tension, between these two mechanisms. The spectrum efficiency of radio systems designed to operate in the most spectrum-efficient manner possible in exclusive spectrum can be compromised by the added interference that often accompanies shared operation. Thus, spectrum sharing or overlaying new services with an incumbent service will not necessarily improve the overall efficiency with

which the spectrum is used, and may not be in the long-term public interest. In short, spectrum sharing may in some cases be at odds with the goal of maximizing spectrum efficiency and encouraging the intensive use of the spectrum.

Spectrum efficiency is often cited as a goal in the context of spectrum management. In today's marketplace, CMRS operators, for example, have a strong economic incentive to maximize spectrum efficiency, because both cell sites and spectrum are expensive.[47] In turn, modern CMRS air interfaces such as CDMA are designed to maximize the spectrum efficiency of the air interface.

CMRS air interfaces achieve high spectrum efficiency by re-using the radio spectrum in multiple cells. The capacity and coverage per cell are therefore interference-limited, because each cell is subject to cochannel interference from other cells.[48] The better the air interface can manage this interference, the higher the spectrum efficiency.

CDMA air interfaces, including the second-generation IS-95 air interface, and the 3G cdma2000 and W-CDMA air interfaces, achieve the highest spectrum efficiency of any CMRS air interfaces by exploiting state-of-the-art communications technology to manage interference in two ways. First, they use sophisticated signal processing techniques such as error-correction coding and multi-branch RAKE receiver diversity combining to minimize the required signal-to-

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[46] *See Spectrum Policy Notice*, at 5 Question Nos. 17-21.

[47] This natural incentive relates to the topic of Question 17 of the *Spectrum Policy Notice*, which states: "What mechanisms or policies might be considered as a means of promoting a proper level of spectral efficiency either through regulatory mandates or economic incentives? Are there mechanisms that other countries use that should be applied in the United States as well?" Sprint believes that the cost of spectrum *via* the competitive bidding process and the cost of deploying the radio infrastructure provides an adequate economic incentive for operators to use spectrum efficiently.

[48] The spectrum-efficiency benefits of frequency reuse and interference-limited operation for CMRS systems are well known and were originally established during development by Bell Labs of the Advanced Mobile Phone System (AMPS). *See* V. H. McDonald, "The Cellular Concept," BELL SYSTEM TECHNICAL JOURNAL, at 15-40 (Jan. 1979).

interference ratio ("SIR"), thereby minimizing the transmit power required to overcome the interference. This maximizes the interference that can be tolerated, thereby maximizing reuse, and also minimizes the interference caused to other users. Second, they use tight power control to keep the actual transmit power level very near the minimum required level, again minimizing interference to other users. Within the limits of available signal processing technology, therefore, CDMA air interfaces use the spectrum as efficiently as possible. As technology evolves, spectrum efficiency can be improved. This is evidenced by the fact that the 3G cdma2000 air interface will deliver roughly twice the spectrum efficiency as IS-95 due to improved coding, signal recovery, and power control techniques.

CMRS network designs are based on the operating principle that the spectrum is completely under the control of the CMRS operator – that is, the dominant impairments are receiver thermal noise and self-interference from other transmitters in the CMRS network. If additional external interference is introduced after a CDMA network is built, it will degrade the capacity and coverage of the network. This is because the CDMA network is interference-limited, and there is a limit on the total interference that can be managed (*i.e.,* an interference budget). If external interference is added, then less cochannel interference from other CDMA transmitters can be tolerated. This reduces the total network throughput that can be achieved while meeting the SIR requirements for each receiver, thereby reducing network capacity and hence spectrum efficiency.

The effect of additional external interference can also manifest itself as a coverage degradation. A handset that would be in a marginal (but covered) location without the external interference may be unable to receive a sufficiently strong signal from the base station to meet its SIR requirement, in the presence of the external interference. If the interference affects the receiver

at the base station, the handset may not be able to transmit sufficient power (on the uplink) to compensate for the added interference.

The net result is that added external interference will degrade the performance of the CDMA system. This degradation will generally be a combination of reduced coverage and reduced spectrum efficiency. There is, therefore, a tradeoff between "spectrum efficiency" gains achieved by overlaying other services on licensed CMRS systems, and the performance of the CMRS system itself. The degrading effects of external interference are especially strong if the CMRS air interface is designed to maximize spectrum efficiency by minimizing the SIR at each receiver (*i.e.*, no unnecessary signal power is transmitted, which is equivalent to using no spectrum resources unnecessarily).

CMRS operators have traditionally designed their networks with the understanding that they have exclusive use of their licensed spectrum, and they have optimized their networks accordingly. If operators must account for the possibility that some unknown new interference level may be introduced at some time in the future, they must necessarily incorporate some unused margin in their interference budgets, which will result in a sub-optimum design. Moreover, without knowing the level of additional interference that might be introduced, the necessary margin cannot be accurately specified. Not only does this situation create an engineering problem, it also creates new coverage gaps that carriers may be unable to rectify. In addition, this situation introduces uncertainty, which tends to have a chilling effect on investment in new network technologies and infrastructure.

In sum, with the "smart" radios used in state-of-the-art communications systems today, adaptive techniques make more efficient use of spectrum. However, because it achieves its efficiency by operating at the minimum limit of acceptable performance, a spectrum-efficient net-

work often is more susceptible to an increase in the level of interference. There is therefore a tradeoff between "spectrum efficiency" gains achieved by overlaying other services on licensed CMRS systems, and the performance of the CMRS system itself. Licensees that choose spectrum-efficient technologies should not, in effect, be punished by the forced introduction of new sources of interference within their licensed band. The irony should not be lost that a spectrum sharing, interference-causing scenario could create disincentives for existing providers to deploy new, more spectrum-efficient technologies, such as 3G.

Sprint stands ready to work with the Spectrum Policy Task Force and the Commission to find ways to ensure that, as advances in communications system technologies develop, the Commission has the capability to enforce licensees' fundamental right to protection from harmful interference so that there remain powerful incentives to develop and implement even more spectrally efficient technologies.

V. CONCLUSION

For the foregoing reasons, Sprint Corporation respectfully requests that the Task Force adopt recommendations consistent with the positions discussed above.

Respectfully submitted,

SPRINT CORPORATION

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